Engineering Evaluation/Cost Analysis

Non Time Critical Removal Support
Gulfco Marine Maintenance Superfund Site
906 Marlin Avenue
Freeport, Brazoria County, Texas
Contract No. EP-W-06-004
EPA Identification No. TXD055144539

Prepared for

U.S. Environmental Protection Agency
Region 6

1445 Ross Avenue, Suite 1200
Dallas, Texas 75202

Prepared by

EA Engineering, Science, and Technology, Inc.
405 S. Highway 121
Building C, Suite 100
Lewisville, Texas 75067
(972) 315-3922

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
AST	Above Ground Storage Tank
AVS/SEM	Acid Volatile Sulfides/Simultaneously Extracted Metals
BCMCD	Brazoria County Mosquito Control Department
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPEC	Constituent of Potential Ecological Concern
DQO	Data Quality Objectives
EA	EA Engineering, Science, and Technology, Inc.
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
GRA	General Response Action
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NFA	No Further Action
NTCRS	Non Time Critical Removal Support
NPL	National Priorities List
O&M	Operation and Maintenance
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbons
PBW	Pastor, Behling & Wheeler, LLC
PSCR	Preliminary Site Characterization Report
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
Site	Gulfco Marine Superfund Site
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SOW	Statement of Work
TAC	Texas Administrative Code
TBC	To Be Considered
TCEQ	Texas Commission on Environmental Quality
TRRP	Texas Risk Reduction Program
URS	URS Corporation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

ENGINEERING EVALUATION / COST ANALYSIS
Gulfco Marine Maintenance Superfund Site
Non Time Critical Removal Support
Freeport, Brazoria County, Texas

EXECUTIVE SUMMARY

This document presents an engineering evaluation and cost analysis (EE/CA) for select removal alternatives for the North Area of the Gulfco Marine Maintenance Superfund Site (Site) located in Freeport, Texas. EA Engineering, Science, and Technology, Inc. (EA) performed the EE/CA for the U.S. Environmental Protection Agency (EPA) Region 6 as part of Task Order No. 0067-NSEE-06JZ under EPA Contract No. EP-W-06-004, in accordance with a Statement of Work (SOW) issued by EPA (October 2010).

The Site was operated by multiple companies as a barge cleaning and maintenance facility from 1971 to 1999. In May 2003, the EPA named the former Gulfco Marine Maintenance facility to the National Priorities List (NPL). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Identification Number assigned to the Site is TXD055144539. This document focus on the selection of removal action alternatives associated with the former surface impoundments, the North Area surface soils, and North Area Surface Water.

Investigative Activities

Soils, sediments and surface water in the North Areas likely became contaminated with constituents of potential ecological concern (COPECs) due to surface runoff from the former surface impoundment area prior to capping.

The final Potentially Responsible Party (PRP) screening level ecological risk assessment (SLERA) (Pastor, Behling & Wheeler, LLC [PBW] 2010a) identified potential risk to lower-trophic receptors such as soil invertebrates in these upland areas. Surface soil collected in support of the PRP baseline ecological risk assessment (BERA) (in preparation) represents the biologically active zone for soil-dwelling invertebrates. Toxicity tests were conducted on surface soils to assess potential effects to these invertebrates. Sediment and surface water was collected in support of the PRP BERA from the North Area. Toxicity tests were conducted on wetland sediments and surface water to assess potential effects to sediment and surface water dwelling invertebrates.

These analytical results for the PRP BERA soil, sediment, and surface water samples were assessed for overall risk through comparison to literature-based screening values and site-specific toxicity testing of representative receptors to site environmental media. Overall, the data collected in support of the PRP BERA met the data quality objectives (DQO) outlined in the

Final BERA Work Plan & SAP (URS Corporation [URS] 2010b) and are adequate for evaluation and risk characterization in the PRP BERA.

The Streamlined Ecological Risk Evaluation (SERE) in Appendix A focused on further addressing risk from surface soils, sediments, and surface water in the North Area.

Toxicity tests of North Area surface soils to soil invertebrates, represented by the marine polychaete, *N. arenaceodentata,* indicated a difference for growth at one sampling location. Toxicity tests of wetland sediments to sediment dwelling invertebrates, represented by the amphipod, *L. plumulosus,* indicated differences in growth at one location. No differences were observed for survival and growth of N. *arenaceodentata* for the North Area sediment. Acute toxicity to the brine shrimp, *A. salina,* was indicated in one surface water sample from the North Area.

While the results of the site-specific toxicity test indicate the potential for adverse effects to benthic invertebrates, risk is likely overestimated due to the intermittent nature of surface water in the wetlands. Depending on rainfall and tide conditions, many of the areas selected for sediment toxicity analysis can often be completely dry. Significant populations of invertebrates would likely be limited to areas with perennial surface water. While individual effects may be present, it is unlikely that population level effects to growth and survival of invertebrates exist from COPECs in site surface soils, sediments and surface waters.

These findings are similar to those of the EA *Technical Memorandum Ecological and Habitat Health Assessment, Wetlands A, B, and C* (EA 2010) which indicated that observed human impacts to the Site wetland habitats are minor. The Site wetlands are not visually distinguishable from surrounding wetlands in terms of wetland species composition and approximate density, presence of invertebrates, and wildlife usage. These wetlands are providing valuable wetland marsh functions, such as wildlife habitat, food, flood storage, water quality enhancement, and ground water recharge. Any disturbance, such as excavation of sediments or other remedial activities, would require decades for sediments in this area to return to the salty sediment marsh type environment present today.

The Appendix A SERE indicates that no further action is necessary based upon the ecological evaluation.

Surface Impoundment Cap Inspection

Based upon the Technical Memorandum - Surface Impoundment Cap Evaluation for Erosion (EA 2010), the thickness of the clay in the cap is approximately 2.5 to 3.5 feet thick. The clay cap is overlain by a six inch layer of crushed oyster shells as a protective layer. The original clay thickness was supposed to be three feet. Additionally, the cap has ruts from vehicle traffic in the western portion. The majority of the ruts are 3 inches in depth with one rut as much as 6 inches in depth. These ruts appear to be the result of vehicular traffic across the cap. The ruts do not appear to have penetrated the entire thickness of the cap at this time and thus have not compromised the integrity of the cap to date.

Removal Action Alternative Summary

The data presented in the Appendix A SERE along with the site inspections and data collected to evaluate the former surface impoundments cap indicates that repair and rehabilitation of the cap may be warranted to mitigate the potential for the cap to be compromised. To address these concerns about the existing surface impoundment cap, three removal alternatives were identified and evaluated. The three alternatives are:

Alternative # 1	No Further Action (NFA)
Alternative # 2	Repair the ruts in the existing cap and return the clay layer to a minimum thickness of three feet. Cover the clay layer with a six inch protective layer of oyster shell and fence the cap area to control access.
Alternative # 3	Repair the ruts in the existing cap and return the clay layer to a minimum thickness of three feet. Cover the clay layer with 18 inches of top soil and vegetate it as a protective layer and fence the cap area to control access.

A brief description of each alternative is presented in Section 6.1. As the presence of the waste material under the cap will be unchanged, institutional controls (which are currently in place) will remain a part of the recommended alternative.

These three alternatives were evaluated based upon cost, effectiveness and implementability. In the comparative analysis of the three alternatives, Alternative # 3 is the most protective of the alternatives but also the most costly. Alternative # 2 is also protective but does not include the increased protection for the clay layer and is less costly than Alternatives # 3. Alternative # 1 will not be effective in addressing the Remedial Action Objectives (RAOs) of meeting the 1982 Texas Water Commission closure direction and repairing the cap to minimize the potential for waste exposure. The EPA will make the final decision regarding which alternative to implement.

1. INTRODUCTION

This document presents the Engineering Evaluation/Cost Analysis (EE/CA) prepared by EA Engineering, Science, and Technology, Inc. (EA) for the Gulfco Marine Superfund Site (Site) located in Freeport, Brazoria County, Texas. EA performed the EE/CA for the U.S. Environmental Protection Agency (EPA) Region 6 as part of the Non Time Critical Removal Support (NTCRS) Task Order No. 0067-NSEE-06JZ under EPA Contract No. EP-W-06-004, in accordance with a SOW issued by EPA (October 2010).

The Site was operated by multiple companies as a barge cleaning and maintenance facility from 1971 to 1999. In May 2003, the EPA named the former Gulfco Marine Maintenance facility to the National Priorities List (NPL). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Identification Number assigned to the Site is TXD055144539. The purpose of this Task Order was to conduct an engineering evaluation and cost analysis for the planned removal activities and to provide the data necessary to select a remedy that eliminates, reduces, or controls risks to human health and the environment.

The Final Preliminary Site Characterization Report (FPSCR) (URS Corporation [URS], November 2010), the Final Nature and Extent Data Report (Pastor, Behling & Wheeler, LLC [PBW], May 2009), the Final Screening Level Ecological Risk Assessment (SLERA) (PBW, May 2010), and the Streamlined Ecological Risk Evaluation (SERE) (Appendix A) provide the basis for this EE/CA.

1.1 PURPOSE OF REPORT

In this EE/CA, potential remedial alternatives are qualitatively developed and assessed against three evaluation criteria to evaluate the relative merits of each alternative and to help identify the preferred alternative. This document focuses on general response actions associated with the former surface impoundments, the North Area surface soils/sediments and North Area Surface Water. The data presented in the Appendix A SERE, along with the site inspections and data collected to evaluate the former surface impoundments cap, indicates that repair and rehabilitation of the cap may be warranted. As such, an EE/CA identifying remedial alternatives to the cap repair is appropriate. This EE/CA summarizes the removal action objectives, identification of potential removal alternatives, and a detailed evaluation of three alternatives for the cap.

The three criteria to be employed in evaluation of removal alternatives are:

- Effectiveness
- Implementability
- Cost

1.2 REPORT ORGANIZATION

In accordance with the SOW, the following information is included in this EE/CA. A discussion of investigative activities is presented in Section 2. Data analysis is presented in Section 3. Risk Evaluation is presented in Section 4. RAOs are presented in Section 5. Identification and analysis of removal action alternatives is presented in Section 6 and Section 7 presents a comparative analysis of removal alternatives.

1.3 SITE LOCATION AND DESCRIPTION

The site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Appendix A - Figure 1). The site consists of approximately 40 acres along the north bank of the Intercoastal Waterway between Oyster Creek (approximately one mile to the east) and the Texas Highway 332 Bridge (approximately one mile to the west). The site includes approximately 1,200 feet of shoreline on the Intercoastal Waterway, the third busiest shipping canal in the United States.

Marlin Avenue divides the site into two primary areas (Appendix A - Figure 2). For the purposes of descriptions in this report, Marlin Avenue is approximated to run due west to east. The property north of Marlin Avenue (the North Area) consists of undeveloped land and closed surface impoundments, while the property south of Marlin Avenue (the South Area) was developed for industrial uses with multiple structures, a dry dock, an above ground storage tank (AST) farm, and two barge slips connected to the Intercoastal Waterway.

Adjacent property to the north, west, and east of the North Area is undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intercoastal Waterway bounds the site to the south. Residential areas are located south of Marlin Avenue, approximately 300 feet west of the site, and 1,000 feet east of the site.

Some of the North Area is upland created from dredge spoil, but most of this area is considered wetlands, as per the United States Fish and Wildlife Service (USFWS) Wetlands Inventory Map (USFWS, 2008). The most significant surface features in the North Area are two ponds (the Fresh Water Pond and the Small Pond) and the closed former surface impoundments (Appendix A - Figure 2). The former surface impoundments and the former parking area south of the impoundments and Marlin Avenue comprise the vast majority of the upland area within the North Area. An area of buried debris is also present immediately south of the capped surface impoundments.

Field observations during the Remedial Investigation indicate the North Area wetlands are irregularly flooded with nearly all of the wetland area inundated by surface water that can accumulate to a depth of one foot or more during extreme high tide conditions, storm surge events (such as hurricanes), and/or in conjunction with surface flooding of Oyster Creek northeast of the site. Due to very low topographic slope and low permeability surface sediments, the wetlands are also very poorly draining and can retain surface water after major rainfall events. Under normal tide conditions and during periods of normal or below normal rainfall, standing water within the wetlands (outside of the two identified ponds discussed below) is typically limited to a small, irregularly shaped area immediately north of the Fresh Water Pond and similar areas south and southeast of the former surface impoundments. Depending on rainfall and tide conditions, these areas can often be completely dry. As such, given the absence of any appreciable area of perennial standing water, the wetlands are effectively hydrologically isolated from Oyster Creek, except during intermittent, and typically brief, flooding events.

Water in the Fresh Water Pond is approximately 4 to 4.5 feet deep and is relatively brackish (PBW, 2009). This pond appears to be a borrow pit created by the excavation of soil and sediment as suggested by the well-defined pond boundaries and relatively stable water levels. Water levels in the Fresh Water Pond are not influenced by periodic extreme tidal fluctuations as the pond dikes preclude tidal floodwaters in the wetlands from entering the pond, except for extreme storm surge events.

The small irregularly shaped area immediately north of the Fresh Water Pond is a salt panne, a shallow depression that retains seawater for short periods of time such that salt accumulates to high levels over multiple tidal cycles.

The Small Pond is a very shallow depression located in the eastern corner of the North Area. The Small Pond is not influenced by daily tidal fluctuations and behaves in a manner consistent with the surrounding wetland (*i.e.*, becomes dry during dry weather, but retains water in response to and following rainfall and extreme tidal events). The Small Pond is also indicative of a salt panne.

Aerial spraying of the wetland areas north of Marlin Avenue, including the North Area, for mosquito control has historically been and continues to be performed by the Brazoria County Mosquito Control District and its predecessor agency, the Brazoria County Mosquito Control Department (both referred to hereafter as BCMCD). Aerial spraying for mosquito control has been performed from altitudes of 50 to 100 feet (Lake Jackson News, 1957)(PBW 2010c). Recently, BCMCD has been using Dibrom©, and organophosphate insecticide, with a diesel fuel carrier through a fogging atomizer application (Facts, 2006, 2008a, 2008b), as well as other compounds such as Scourge™, Kontrol 30-30, and Fyfanon® (personal communication between Gary Miller [USEPA] and Fran Henderson [BCMCD]). Truck-based spraying has also been performed along Marlin Avenue. Both types of spraying were observed during the performance of site Remedial Investigation activities.

2. INVESTIGATIVE ACTIVITIES

Multiple phases of investigation have been completed as part of the remedial investigation. Most recently, sediment and surface water, and Intercoastal Waterway sediment samples were collected in support of the PRP BERA. The following section presents a summary of the data pertinent to the development of the EE/CA.

2.1 TERRESTRIAL ENVIRONMENT

Investigation of site terrestrial areas was limited to the upland regions in the North Area including the former surface impoundments and the area south of the former impoundment. Soils in these areas likely became contaminated with constituents of potential ecological concern (COPECs) due to surface runoff from the former surface impoundment area prior to capping. The final PRP SLERA identified potential risk to lower-trophic receptors such as soil invertebrates in these upland areas. Media collected in support of the PRP BERA included surface soils (0-6 inches below ground surface [bgs]), which represents the biologically active zone for soil-dwelling invertebrates. Toxicity tests were also conducted on surface soils to assess potential effects to these invertebrates. The analytical data for each sample are presented in Appendix A of the *Final Preliminary Site Characterization Report* (FPSCR) (PBW, 2010) and are summarized in Appendix A - Table 1 of the SERE.

2.1.1 North Area Surface Soil Sample Collection and Analysis

A total of six surface soil samples were collected (0-6 inches bgs) from the North Area. Five samples (NAS01 to NAS05) were collected in the area south of the former surface impoundment area, and one sample (NAS06) was collected in the northwest corner of the former surface impoundment area (Appendix A - Figure 3a). An additional three samples, NAS07, NAS08, and NAS09, were collected in the soil reference area approximately 2000 ft east of the site (Appendix A - Figure 3b).

All samples were analyzed for the following metals identified as COPECs in previous steps of the risk assessment process:

- Barium
- Chromium
- Copper, and
- Zinc

In addition, 3 of the 6 soil samples from the North Area (NAS02, NAS03, and NAS05) were analyzed for 4,4'-DDT and Aroclor-1254 (see Appendix A SERE).

2.1.2 North Area Surface Soil Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted on the six surface soil samples collected from the North Area and the three reference samples to evaluate direct toxicity to soil-dwelling invertebrates. A 28-day earthworm (*Eisenia fetida*) chronic bioassay was originally proposed in the *Final BERA Work Plan and SAP* (URS, 2010b); however, elevated salinity in the surface soil samples made use of the earthworm problematic.. When earthworms were introduced to the North Area soil samples there was an immediate avoidance reaction followed by acute mortality in all of the site and background samples. The elevated salinity levels are believed to be due to frequent inundation of estuarine during storm events. Also, much of the soil was originally dredge spoils from the Intercoastal Waterway, which was used as a fill material.

An alternative to the earthworm bioassays was developed following discussion and agreement by the USEPA. This alternative treated the soils samples as sediments by adding synthetic seawater and exposing the marine polychaetous annelid, *Neanthes arenaceodentata*, to a 21-day bioassay to assess growth and survival. Polychaetes are more taxonomically similar to and occupy a similar feeding guild to earthworms. The North Area soil toxicity testing was conducted from September 10 through October 1, 2010.

2.2 AQUATIC ENVIRONMENT

Investigation of site aquatic areas includes the wetland areas of the North Area. Media (sediments and surface water) in these areas likely became contaminated with COPECs from direct discharge from barge cleaning operations, surface runoff, and flooding mechanisms. The final PRP SLERA identified potential risk to sediment and surface water dwelling invertebrates. Media collected in support of the PRP BERA included bulk sediments (0-6 inches bgs) and surface water from the North Area wetlands. Sediment pore water was also extracted from bulk sediments. The analytical data for each sample are presented in Appendix A of the PSCR and are summarized in Appendix A - Table 2 to Table 4 of the SERE.

2.2.1 North Area Wetland Bulk Sediment Sample Collection and Analysis

A total of seven bulk sediment samples were collected (0-6 bgs) from the North Area wetlands. Five samples (EWSED03 to EWSED07) were collected in the wetland areas south of the former surface impoundment area, and two samples (EWSED01 and EWSED02) were collected north of the Fresh Water Pond (Appendix A - Figure 4). An additional two samples, EWSED08 and EWSED09, were collected in the sediment reference area north of the site and west of the former surface impoundments (Appendix A - Figure 4).

All samples were analyzed for the following parameters identified as COPECs in previous steps of the risk assessment process:

- Polycyclic Aromatic Hydrocarbons (PAHs): 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene
- Pesticides: 4,4'-DDT, endrin aldehyde, endrin ketone, gamma-chlordane
- Metals: arsenic, copper, lead, nickel, zinc
- Acid Volatile Sulfides/Simultaneously Extracted Metals (AVS/SEM)
- Grain size analysis

In addition to the bulk sediment samples, pore water was extracted and analyzed for COPECs for all but one sediment sample (EWSED05). This sample was too dry to extract pore water. These data are presented in Appendix A SERE.

2.2.2 North Area Wetland Bulk Sediment Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted on the seven site sediment samples collected from the North Area and the two reference samples to evaluate direct toxicity to sediment-dwelling invertebrates. Two 28-day chronic bioassays were conducted using the amphipod, *Leptocheirus plumulosus*, and the polychaete, *Neanthes arenaceodentata*. Both organisms were selected for toxicity testing because both are representative of common species found along the Texas gulf coast, are sensitive to site COPECs, and are tolerant to a wide range of sediment and salinity conditions. Study endpoints of growth, mortality, and reproduction were measured for the *Leptocheirus* bioassay, while only the growth endpoint (with mortality data used to assist in the calculations) was used for the *Neanthes* bioassay.

2.2.3 North Area Wetland Surface Water Sample Collection and Analysis

A total of three surface water samples were collected from the North Area wetlands. One sample (EWSW01) was collected in the area north of the Fresh Water pond. One sample (EWSW03) was collected in the small, irregularly shaped waterbody south of the former surface impoundment, and one sample (EWSW04) was collected from the near the Small Pond (Appendix A - Figure 5). Surface water was not present at the reference location (EWSW02), no analysis could be performed.

All surface water samples were analyzed for the following parameters identified as COPECs in previous steps of the risk assessment process:

- Acrolein (EWSW01 only)
- Dissolved copper
- Dissolved nickel
- Dissolved silver
- Dissolved zinc

2.2.4 North Area Wetland Surface Water Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted on the three site surface water samples collected from the North Area to evaluate direct toxicity to surface water-dwelling invertebrates. A 7-day chronic bioassay analysis that measured the survival and growth of the mysid shrimp, *Mysidopsis bahia,* was originally proposed in the *Final BERA Work Plan & SAP* (URS, 2010b); however, elevated salinity in the surface water samples from the salt panne areas (40% salinity at EWSW01 and 39% at EWSW04) made use of this test organism problematic.

An alternative to the mysid shrimp bioassays was developed following discussion and agreement by the USEPA. This alternative used the brine shrimp (*Artemia salina*), which is better suited to high salinities. Furthermore, since *A. salina* is typically more sensitive to environmental contaminants than fish, toxicity data should be protective of the fish community. No standards have been established for toxicity testing conducted on brine shrimp and a standard operating procedure (SOP) was developed by the analytical lab by referencing SOPs available for determining toxicity to produced (oil field) waters. The test protocol was shortened from 7 days to 96 hours and measured acute mortality of the organisms as the test endpoint. The shortened test period would likely be more representative of the intermittent nature of the surface water being evaluated in the North Area wetlands.

Surface water toxicity tests were conducted three times between September 16 and October 3, 2010 due to several factors including an incorrect food source being used for the test organism and control failures.

2.3 CAP ASSESSMENT

In addition to the supplemental investigative activities detailed above, an evaluation of the cap installed above the former surface impoundments was also performed. The evaluation of the cap was necessary to evaluate the continued effectiveness of this remedy. The surface impoundments were closed under the Texas Water Commission's (Texas Commission on Environmental Quality [TCEQ] predecessor agency) direction in 1982 (PBW, 2010). There is currently no formal operation and maintenance (O&M) program in place. Visual inspections along with samples of surface impoundment cap have been performed by PBW (PBW, May 2009) and EA. The most recent inspection and data collection effort was performed in December 2010. Information regarding this data collection effort was reported in the Technical Memorandum – Surface Impoundment Cap Evaluation for Erosion (EA, December 2010). Soil data collected from the additional borings taken in December 2010 are in Table 1.

The following presents a summary of the available information regarding the current status of the cap:

- The upper surface of the cap consists of crushed shells (approximately six inches in thickness).
- The oyster shell cover seems to have protected the clay layer from erosion during storm events as there are no obvious signs of erosion.
- Cap vegetation consists of mostly volunteer grasses with some brush. The majority of the brush is located along the perimeter of the cap with isolated patches within the interior portions of the cap.
- Access to the cap is not controlled.
- The cap clay layer has been documented to be generally 2.5 to 3.5 feet thick (PBW, May 2009).
- Rutting is present along the western portion of the cap. These ruts are due to vehicular traffic. The ruts are generally no more than 3 inches in depth with one location found to be approximately 6 inches deep.

The ruts do not appear to have penetrated the entire thickness of the cap at this time and do not seemed to have compromised the integrity of the cap to date. It is not known if the rutting could lead to exposure of waste.

3. DATA ANALYSIS

The following section presents a discussion of the data used to support the EE/CA. The data used was collected by both EA (for the cap and borrow pit evaluation) and URS (for the PRP Baseline Ecological Risk Assessment (BERA). The SERE prepared as part of the NTCRS Task Order (EA 2010) is included as Appendix A, and includes data from toxicity studies that are not included in any PRP reports to date. The nature and extent of the contaminants of interest (COIs) was presented in the PBW, May 2009. For the purpose of this document, information regarding the nature and extent of contamination deemed relevant for preparation of the EE/CA is summarized below.

3.1 CAP DATA

As previously stated, the Cap material has been evaluated on several occasions and presented in Section 2.3. A consolidated summary of this information is included in Table 1. The cap could benefit from some repair and rehabilitation.

3.2 ECOLOGICAL DATA SUMMARY

The Appendix A SERE focused on further addressing risk from surface soils and sediments in the North Area and surface waters in the North Area wetlands. Potential risk was evaluated through the additional data analysis.

Toxicity tests of North Area surface soils to soil invertebrates, represented by the marine polychaete, *N. arenaceodentata,* indicated a difference for growth at one sampling location. Toxicity tests of wetland sediments to sediment dwelling invertebrates, represented by the amphipod, *L. plumulosus,* indicated differences in growth at one location. No significant differences were observed for survival and growth of N. *arenaceodentata* for the North Area sediment. Acute toxicity to the brine shrimp, *A. salina,* was indicated in one surface water sample from the North Area.

While the results of the site-specific toxicity test indicate the potential for adverse effects to benthic invertebrates, risk is likely overestimated due to the intermittent nature of surface water in the wetlands. Depending on rainfall and tide conditions, many of the areas selected for sediment toxicity analysis can often be completely dry. Significant populations of invertebrates would likely be limited to areas with perennial surface water. While individual effects may be present, it is unlikely that population level effects to growth and survival of invertebrates exist from COPECs in site surface soils, sediments and surface waters.

These findings are similar to those of the EA *Technical Memorandum Ecological and Habitat Health Assessment, Wetlands A, B, and C* (EA 2010) which indicated that observed human impacts to the Site wetland habitats are minor. The Site wetlands are not visually distinguishable from surrounding wetlands in terms of wetland species composition and approximate density, presence of invertebrates, and wildlife usage. These wetlands are providing valuable wetland marsh functions, such as wildlife habitat, food, flood storage, water quality enhancement, and ground water recharge. Any disturbance, such as excavation of sediments or other remedial activities, would require decades for sediments in this area to return to the salty sediment marsh type environment present today.

4. RISK EVALUATION

The following section presents a summary of the risk assessments performed for the site. Both human health and ecological receptors were considered. The PRP Final Baseline Human Health Risk Assessment (BHHRA) (PBW 2010a) presented a detailed summary of the human health risks. Conclusions from the PRP Final BHHRA indicated there were not unacceptable cancer risks nor non-cancer hazard indices for any of the five current or future exposure scenarios except for future exposure to an indoor industrial worker if a building is constructed over impacted ground water. The ecological risk evaluation presented in the Appendix A SERE concluded the saltwater marsh area is a sensitive marsh sediment habitat created by years of temporary inundation by saltwater. Any disturbance of surficial sediments would require decades for sediments in this area to return to the salty sediment marsh type environment present today. This fact, along with the data presented in the Appendix A SERE, suggests that response actions for the risk associated with direct contact to invertebrates in the soil, sediments, and surface water is not warranted.

5. REMOVAL ACTION OBJECTIVES

According to the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] §300.430[a][1][I]), the goal of the remedy selection process is "to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." RAOs are medium-specific (e.g., soil or ground water) goals that address the requirements for protecting the human health and the environment (USEPA, 1988). In addition, Site actions must comply with Applicable or Relevant and Appropriate Requirements (ARARs) relating to each action taken.

5.1 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

As discussed in Section 2.3, existing site conditions indicate the need for some sort of repair to the cap in the form of a removal action to maintain protection over time. The RAOs are typically developed for exposure pathways posing an unacceptable risk. RAOs were identified for the Former Surface Impoundments to maintain protection over time.

5.1.1 Former Surface Impoundments

As evidenced by the data from the cap investigations and the requirements set forth in the TCEQ Technical Guideline No. 3 (TCEQ, June 2009), the cap material is of sufficient vertical hydraulic conductivity but does not meet the criteria set forth in the 1982 Texas Water Commission's closure direction, for clay layer thickness. Additionally the rutting on the western portion of the cap needs repair. Based on this information, the RAOs for this area are: (1) Repair the cap to minimize the potential for waste exposure; and (2) restore the thickness of the clay layer to three feet.

5.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are federal and state environmental laws and regulations that specify clean-up levels or performance standards for CERCLA sites.

Section 121(d) of CERCLA, as amended by Superfund Amendments and Reauthorization Act, states that on-site remedial actions must attain ARARs. ARARs may include regulations, standards, criteria, or limitations promulgated under federal or state laws. An ARAR may be either "applicable" or "relevant and appropriate," but not both. The NCP in 40 CFR §300 defines ARARs (EPA, 1994).

Three categories of ARARs exist: chemical-, location-, and action-specific requirements. Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical clean-up values. These values establish the acceptable amount or concentration of a chemical that may be detected in or discharged to the ambient environment. Location-specific ARARs are restrictions on the concentrations of hazardous substances or on activities conducted at the Site that result from site characteristics or its immediate environment. For example, location of the Site or proposed remedial action in a flood plain, wetland, historic place, or sensitive ecosystem may trigger location-specific ARARs. Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken. These requirements are triggered by the specific remedial activities selected. Action-specific ARARs do not in themselves determine the remedial alternative; rather, they indicate how an alternative must be conducted (EPA, 1994).

In addition to the legally binding requirements established as ARARs, many federal and state programs have developed criteria, advisories, guidelines, or proposed "To Be Considered" (TBC) standards. TBC material may provide useful information or recommend procedures if no ARAR addresses a particular situation or if existing ARARs do not provide protection. In such situations, TBC criteria or guidelines should be used to set remedial action levels. TBC criteria are not legally binding and do not have the status of ARARs.

Chemical-, location-, and action-specific ARARs for the remedial alternatives are listed below.

Federal Chemical-Specific ARARs

- Clean Water Act (33 USC Section 1251-1376)
    - 40 CFR Part 131 (Water Quality Criteria) – Sets criteria for ambient water quality on the basis of toxicity to aquatic organisms and human health.
    - 40 CFR Part 136 (EPA Guidelines Establishing Test Procedures for the Analysis of Pollutants) – Establish EPA regulations on test procedures for the analysis of pollutants
- Resource Conservation and Recovery Act (RCRA) (42 USC 6905, 6912, 6924, 6925)

- 40 CFR Part 261 (Identification and Listing of Hazardous Waste) – Defines those solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262-265 and Parts 124, 270, and 271.

Federal Action-Specific ARARs

- 40 CFR 264.228 – Surface Impoundments – Provides criteria for closure and post-closure care

State of Texas Action-Specific ARARs

- Title 30 Texas Administrative Code (TAC) Chapter 111 - Requires that all reasonable precautions shall be taken to prevent particulate matter from becoming airborne, including use of water or chemicals for control of dust. Applicable during site excavation activities.
- Title 31 TAC Chapter 501 Subchapter B 501.23 – Policies for development in critical areas.
- Texas Commission on Environmental Quality – Industrial Solid Waste Management, Technical Guideline No. 3 – Sets forth requirements for landfill cover design.
- Title 30 TAC Chapter 335, Subchapter F – Sets forth specific requirements for industrial hazardous waste landfills.
- Title 30 TAC Chapter 335, Subchapter T – Sets forth specific requirements for commercial industrial nonhazardous waste landfills.
- Title 30 TAC Chapter 335, Subchapter O – Land Disposal Restriction standards for the disposal of hazardous wastes.

Federal Chemical-Specific Potential ARARs

- Clean Air Act (42 USC Section 7401-7642)
    - 40 CFR Part 50 (National Primary and Secondary Ambient Air Quality Standards)–Establish standards for ambient air to protect public health and welfare (including standards for particulate matter and lead).
- Resource Conservation and Recovery Act (RCRA) (42 USC 6905, 6912, 6924, 6925)
    - 40 CFR Part 264 (RCRA Ground Water Protection) – Provides for ground water protection standards, general monitoring requirements, and technical requirements.
    - 40 CFR Part 257.3-4 (RCRA Solid Waste Disposal Facility Requirements)- Provides for protection of ground water at solid waste disposal facilities.

Federal Chemical- and Action-Specific Potential ARARs

- RCRA (42 USC 6905, 6912, 6924, 6925)
    - 40 CFR Part 268 (Land Disposal Restrictions) – Establish a timetable for restriction of burial of wastes and other hazardous materials.

Federal Action-Specific Potential ARARs

- RCRA (42 USC Sections 6901-6987)
    - 40 CFR Part 257 (Criteria for Classification of Solid Waste Disposal Facilities and Practices) – Establish criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health, and thereby constitute prohibited open dumps.
- Hazardous Materials Transportation Act (49 USC Sections 1801-1813)
    - 49 CFR Parts 107, 171-177 (Hazardous Materials Transportation Regulations) – Regulate transportation of hazardous materials.

Federal Location-Specific Potential ARARs

- Fish and Wildlife Coordination Act (16 USC Sections 661-666) – Requires consultation when a federal department or agency proposes or authorizes any modification of any stream or other body of water and adequate provision for protection of fish and wildlife resources.
- Endangered Species Act of 1973 (16 USC 1531-1544) – Provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife and plants depend.
- Clean Water Act (33 USC Section 1251-1376) – Section 404 of the Clean Water Act established a program to regulate the discharge of dredged or fill material into waters of the United States.

State of Texas Chemical-Specific Potential ARARs

Title 30 TAC Chapter 307 – Establishes limits for constituents for the protection of surface water quality.

State of Texas TBCs

- Texas Risk Reduction Program (TRRP) Title 30 Chapter 350 – Establishes the TCEQ's minimum remediation standards for present and past uncontrolled constituent releases using risk evaluation to determine if corrective action is necessary.

Federal Potential TBCs

- EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9347.3-06FS – Guidance in establishing cleanup goals dealing with treatment levels for contaminated soil and sediment.
- Final Guidance, Superfund Removal Guidance for Preparing Action Memoranda, September 2009.
- Federal Ambient Water Quality Criteria – Establish protection of aquatic organisms and human health from contaminated sediment.

6. IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section presents a list of potential alternatives and then evaluates the alternatives against the criteria. This is used to discuss the merits of each alternative.

6.1 APPLICABLE REMOVAL ALTERNATIVES

This section presents a list of removal alternatives potentially applicable to remediation of the impacted soils/sediments at the former surface impoundment area in Lot 56. Figure 1 shows the current topography of the closed former surface impoundment area in Lot 56.

In general, the alternatives fit into one or more category of general response actions (GRA). GRAs are generic, medium-specific, remedial actions that will satisfy the RAOs discussed earlier. GRAs may include no action, institutional controls, containment, removal, treatment, disposal, monitoring, or a combination thereof (EPA, 1988). The development of remedial alternatives begins with the identification of GRAs that can meet RAOs, which are then screened and developed into remedial alternatives to address all contaminated media at the Site. Alternatives for the remediation of soil will fall into GRAs No Further Action (NFA), institutional controls, containment, removal, and treatment. All alternatives deal with the former surface impoundment area shown on Figure 1.

The following three alternatives were considered.

Alternative # 1 No Further Action (NFA).

Alternative # 2 Repair the ruts in the existing cap and return the clay layer to a minimum thickness of three feet. Cover the clay layer with a six inch protective layer of oyster shell and fence the cap area to control access (Containment).

Alternative # 3 Repair the ruts in the existing cap and return the clay layer to a minimum thickness of three feet. Cover the clay layer with 18 inches of top soil and vegetate it as a protective layer and fence the cap area to control access (Containment).

A brief description of each alternative is presented below. As the presence of the waste material under the cap will be unchanged, institutional controls will be required to remain a part of each of the recommended alternatives.

6.1.1 Alternative # 1

As required by the NCP (40 CFR § 300.430 [e] [6]), remedial alternatives must include the NFA alternative to be used as the baseline alternative against which the effectiveness of all other remedial alternatives are judged. The NFA alternative may not be effective in addressing the RAOs for the Site, but is retained per NCP requirement for future evaluation to provide a baseline for comparison against other technologies. At present there are institutional controls in the form of Restrictive Covenants on Lots 55, 56, and 57, executed in July of 2009. The covenants restrict the use of the property to commercial/industrial use and allow no human habitation. The covenant also restricts use of ground water for any purpose. The EPA and TCEQ must approve of any plans to construct a building on any of the Lots.

6.1.2 Alternative # 2

Implementation of the second alternative would include repairing the rutted areas of the existing cap. The rehabilitation of the surface impoundment cap would include removal of the oyster shells that lie on top of the cap, the addition of approximately 0.5 feet of additional clay material to bring the minimum thickness of the clay layer up to three feet to meet the 1982 Texas Water Commission's directive and install approximately six inches of oyster shell as a protective layer. A three wire barbed fence would then be installed at the toe of the cap around the entire perimeter to control access with an access gate on the south side. An operations and maintenance program would also be implemented to maintain the cap.

6.1.3 Alternative # 3

Implementation of the third alternative would include repairing the rutted areas of the existing cap. The rehabilitation of the surface impoundment cap would include removal of the oyster shells that lie on top of the cap, the addition of approximately 0.5 feet of additional clay material to bring the minimum thickness of the clay layer up to three feet to meet the 1982 Texas Water Commission's directive and install approximately 18 inches of topsoil. The surface of the cap would then be seeded to provide vegetative cover for the cap. A three wire barbed fence would then be installed at the toe of the cap around the entire perimeter to control access with an access gate on the south side. An operations and maintenance program would also be implemented to maintain the cap.

6.2 ALTERNATIVE EVALUATION

Three criteria (effectiveness, implementability, and cost) were used to evaluate remedial alternatives. Definitions for these evaluation criteria are presented below, and the results of the evaluation are summarized on Table 2.

6.2.1 Effectiveness

This criterion is a measure of the ability of an option to: (1) reduce toxicity, mobility, or volume; (2) minimize residual risks; (3) afford long-term protection; (4) comply with ARARs; (5) minimize short-term impacts; and (6) achieve protectiveness in a limited duration. Alternatives that offer significantly less effectiveness than other proposed technologies may be eliminated from the alternative development process. Options that do not provide adequate protection of human health and the environment likewise are eliminated from further consideration.

6.2.2 Implementability

Implementability is a measure of the technical feasibility and availability of the option and the administrative feasibility of implementing it (e.g., obtaining permits for off-site activities, rightsof-way, or construction). Options that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period may be eliminated from further consideration.

6.2.3 Cost

Qualitative relative costs for implementing the remedy are considered. Alternatives that cost more to implement, but offer no benefit in effectiveness or implementability over other technologies, may be excluded from the alternative development process.

6.3 ALTERNATIVE EVALUATION SUMMARY

The results of the alternative evaluation are summarized in Table 2. Each of the three alternatives discussed above have been retained for further evaluation. The alternatives are subjected to further analysis in Section 7.0.

7. COMPARATIVE ANALYSIS OF REMOVAL ALTERNATIVES

This section evaluates the remedial alternatives presented in Section 6 using the three criteria mentioned previously: 1) Effectiveness, 2) Implementability, and 3) Cost. The comparison criteria and evaluation process are discussed below and Table 2 presents the evaluation of the three remedial alternatives.

7.1 COMPARATIVE ANALYSIS

Each alternative is evaluated in terms of risk that remains at the Site after the RAO has been met. The primary focus of this evaluation is the extent and effectiveness of controls used to manage the risk posed by treatment residuals or untreated wastes.

7.1.1 Effectiveness

The following factors will be considered in evaluating this criterion:

- Adequacy of remedial controls
- Reliability of remedial controls
- Magnitude of the residual risk

Alternative # 1

Since this alternative consists of no action, this alternative may not be effective at addressing the potential risk for release of contaminants if the surface impoundment cap is not repaired or maintained. This alternative is used as a reference for the remaining alternatives.

Alternative # 2

Alternative # 2 consists of repairing and rehabilitating the existing surface impoundment cap. This alternative will reduce the risks posed by the potential for a breach of the cap and control access. This alternative will be more effective than Alternative # 1.

Alternative # 3

Alternative # 3 consists of repairing and rehabilitating the cap and installing thicker vegetated cover. This alternative will reduce the risks posed by the potential for a breach of the cap. Additionally, this alternative will be more protective of the clay layer and control access. This alternative will be more effective than Alternative # 1, however the soil cover will be more susceptible to erosion before it is fully vegetated and during storm events may not be as effective as Alternative # 2 in controlling erosion in the long term.

7.1.2 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials that may be required during its implementation. The following factors were considered:

- Ability to construct the technology
- Monitoring requirements
- Availability of equipment and specialists
- Ability to obtain approvals from regulatory agencies

For each of the three alternatives, standard earth-moving equipment such as dozer and excavator are necessary to implement the alternative. Locating a borrow source with sufficient clay material for the cap would be the most challenging task. Each alternative would be implementable.

7.1.3 Cost

The cost for each alternative is calculated from estimates of capital and operation and maintenance (O&M) costs. Capital costs consist of direct and indirect costs. Direct costs include the purchase of equipment, labor, and materials necessary to implement the alternative. Indirect costs include engineering, financial, and other services such as testing and monitoring. Annual O&M costs for each alternative include operating labor, maintenance materials and labor, auxiliary materials, and energy. For the alternatives described herein, the O&M costs would consist of costs for cap maintenance.

The cost estimate is normally expected to fall within the range of 50 percent above to 30 percent below the actual project cost (accuracy of + 50% and – 30 %). Cost estimates for remediation alternatives are presented in Tables 3 and 4 and are summarized below.

Alternative	Annualized Cost + 50% - - 30%
1	$0
2	$866,500-$404,300
3	$1,450,400-$676,800

The evaluation of the three alternatives is summarized in Table 2. The EPA will make the decision as to which alternative to implement.

REFERENCES

Pastor, Behling & Wheeler, LLC (PBW), 2009. *Nature and Extent Data Report, Gulfco Marine Maintenance Site, Freeport, Texas.* May 3.

Pastor, Behling & Wheeler, LLC (PBW), 2010a. *Final Baseline Human Health Risk Assessment, Gulfco Marine Maintenance Site, Freeport, Texas.* March 31.

Pastor, Behling & Wheeler, LLC (PBW), 2010b. *Final Screening Level Ecological Risk Assessment Report, Gulfco Marine Maintenance Site, Freeport, Texas.* May 3.

Pastor, Behling & Wheeler, LLC (PBW). 2010c. *Preliminary Site Charucterization Report (PSCR), Gulfco Marine Maintenance Site, Freeport, Texas.* November 3.Lake Jackson News. 1957.

Personal communication between Gary Miller (EPA) and Fran Henderson (BCMCD), 27 October 2010.

EA Engineering Science and Technology, 2010. *Technical Memorandum – Surface Impoundment Cap Evaluation for Erosion*, December

Texas Commission on Environmental Quality (TCEQ) 2009. June 2009. Technical Guideline No. 3

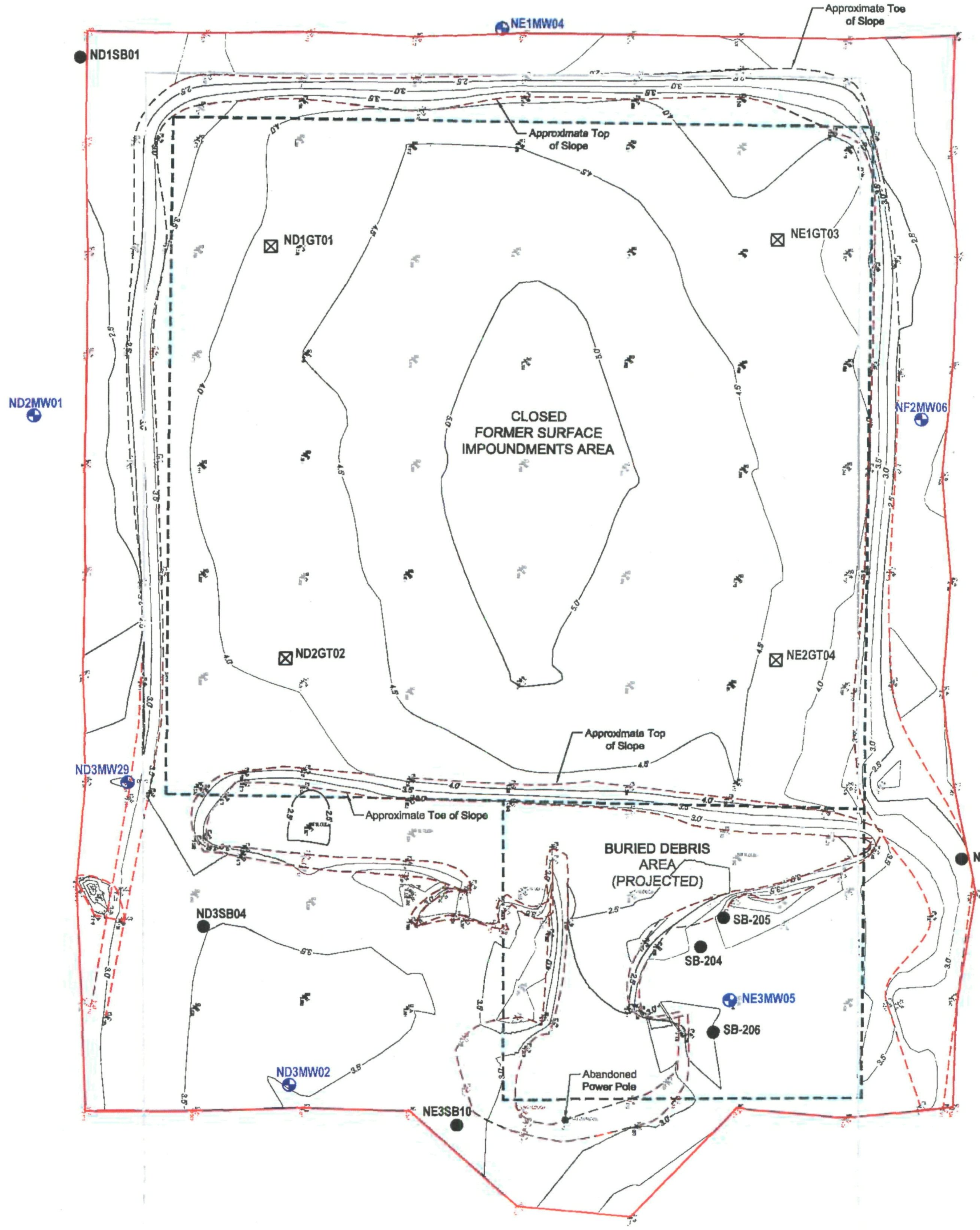
USEPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (Interim Final). OSWER Directive 9355.3-01. EPA/540/G-89-004. October.*

USEPA. 1994. "National Oil and Hazardous Substances Pollution Contingency Plan." Title 40 Code of Federal Regulations, Part 3 and 59 Federal Register 47384. 18 October.

URS Corporation (URS), 2010a. *Final Baseline Ecological Risk Assessment Problem Formulation Report, Gulfco Marine Maintenance Site*, Freeport, Texas. September 2.

URS Corporation (URS), 2010b. *Final Baseline Ecological Risk Assessment Work Plan & Sampling and Analysis Plan, Gulfco Marine Maintenance Site*, Freeport, Texas. September 2.

FIGURES



EXPLANATION

- Monitoring Well Location
- Geotechnical Soil Boring
- Soil Boring Location
- Elevation Measurement Location
- Ground Surface Elevation (Ft Mean Sea Level, NGVD 29) - Minor Contour Line
- Ground Surface Elevation (Ft Mean Sea Level, NGVD 29) - Major Contour Line
- Extent of Surface Impoundments and Buried Debris Area (Projected)
- Top/Toe of Slope (Approximate)
- Lot 56 Property Line
- Limits of Topographic Survey

N

Approx. Scale in Feet

0 25 50

Source: Doyle & Wachtstetter, Inc. Field Survey May 26, 2009

GULFCO MARINE MAINTENANCE
FREEPORT, BRAZORIA COUNTY, TEXAS

Figure 1

FORMER SURFACE IMPOUNDMENTS TOPOGRAPHIC MAP

PROJECT 1352	BY ZGK	REVISIONS
DATE: DEC., 2010	CHECKED EFP	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

Tables

Table 1

SUMMARY OF CAP INVESTIGATION DATA
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Boring Location	Cap Material Description	Observed Cap Thickness (feet)	Liquid Limit (2) (%)	Plastic Limit (2) (%)	Plasticity Index (2) (%)	Percent Passing # 200 Sieve (3) (%)	Moisture Content (4) (%)	Vertical Hydraulic Conductivity (5) (cm/sec)
PBW Investigation - 2009								
ND1GT01	Sandy Lean Clay	2.9	48	16	32	70	20	3.5×10^{-8}
ND2GT02	Lean Clay with Sand	>3.5	49	14	35	84	23	1.4×10^{-8}
NE1GT03	Lean Clay with Sand	2.5	49	13	35	74	19	5.0×10^{-9}
NE2GT04	Fat Clay	3.6	58	15	43	88	26	5.9×10^{-9}
EA Investigation - December 2010								**Vertical Hydraulic Conductivity (6) (cm/sec)**
South Cap Boring	Light Brown Clay	--	--	--	--	--	25	4.4×10^{-9}
Central Cap Boring	Brown Clay	--	--	--	--	--	25	5.6×10^{-9}
West Cap Boring	Tan Clay	--	--	--	--	--	25	4.3×10^{-9}
TCEQ Technical Guideline No. 3 Recommended Value/Range			--	--	10-35	> 20	--	$< 1.0 \times 10^{-7}$

Notes:
1) Crushed oyster shell surface observed above clay cap at all boring locations - PBW 2009, EA 2010.
2) ASTM Method D 4318
3) ASTM Method D 1140
4) ASTM Method D 2216
5) US Army Corp of Engineers, Engineering Manual Method 1110-2-1906
6) ASTM-D 5084

TABLE 2
Page 1 of 1
REMOVAL ALTERNATIVE EVALUATION
GULFCO MARINE MAINTENANCE SUPERFUND SITE

General Response Action	Alternative #	Components	Brief Description	Effectiveness	Implementability	Cost	Status
No Action	1	No Action	No action	Not effective in addressing RAOs	Implementable	Low	Retained
Containment	2	Repair Existing Surface Impoundment Cap Return to Original Specifications, Perimeter Fence.	Address the potential risk for breaching of the existing surface impoundment cap due to existing ruts and access.	Would be effective in reducing risks associated with the existing surface impoundment cap and controls access.	Implementable - cap maintenance will need to be performed for life of the cap.	Moderate	Retained
Containment	3	Repair Existing Surface Impoundment Cap Return to Original Specifications Install Topsoil and Vegetative Cover, Perimeter Fence.	Address the potential risk for breaching of the existing surface impoundment cap, provides more protection for the clay by increasing top cover thickness and access.	Would be effective in reducing risks associated with the existing surface impoundment cap and provides additional protection that will aid in maintenance costs and controls access.	Implementable - cap maintenance will need to be performed for life of the cap.	Moderate	Retained

Table 3 - COST ESTIMATE - ALTERNATIVE # 2

Gulfco Marine Maintenance Superfund Site

Site: Gulfco Marine Maintenance
Location: Freeport, Brazoria County, Texas
Base Year: 2010
Date: January 14, 2011

Description: Perform Upgrade to the Cap. Includes 5 years cap maintenance.

Assumptions: Upgrades to the cap will include removing the approximately 0.5' layer of oyster shells on top of the cap, installing an additional 0.5- foot layer of clay material, placing 0.5' of oyster shells on cap and installing a 3-wire fence around former surface impoundment at toe.

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES	PRESENT VALUE AT 7%
CAPITAL COSTS						
REMEDIAL DESIGN						
Remedial Design						
Remedial Design	1	LS	$ 36,200	$ 36,200	Professional estimate (8% of Site Preparation and Cap Upgrade Construction)	
REMEDIAL DESIGN SUBTOTAL				$ 36,200		$ 36,200
SITE PREPARATION						
Site Prep						
Erosion Control Plan Development & Submittals	1	LS	$ 12,000	$ 12,000	Professional estimate	
Site Survey/Utility Locate	3	acres	$ 1,500	$ 4,500	RS Means *2005 Environmental Remediation Cost Data*	
Erosion Control Implementation - Silt Fencing	2,000	ft	$ 3.50	$ 7,000	Professional estimate	
Construct Decon Station for Trucks and Heavy Equipment	1	LS	$ 4,800	$ 4,800	Professional estimate	
Equipment Delivery	5	each	$ 300.00	$ 1,500	Professional estimate	
Miscellaneous Materials	1	each	$ 5,000	$ 5,000	Professional estimate	
Wheel Loader	3	days	$ 350	$ 1,050	Hertz equipment rental	
Pickup Trucks (2)	6	days	$ 80	$ 480	Professional estimate	
Labor						
Site Superintendent	30	hrs	$ 110	$ 3,300	Professional estimate	
QA Officer	30	hrs	$ 110	$ 3,300	Professional estimate	
Operator (2)	60	hrs	$ 75	$ 4,500	Professional estimate	
Technician	30	hrs	$ 65	$ 1,950	Professional estimate	
Site Safety and Health Officer	30	hrs	$ 110	$ 3,300	Professional estimate	
Per Diem	3	days	$ 720	$ 2,160	Professional estimate	
Site Prep Subtotal				$ 54,840		
Professional Services, Project Management, and Fees						
Legal Fees for Institutional Controls and Deed	1	LS	$ 4,000	$ 4,000		
Project management	5%	of subtotal		$ 2,700	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 1,600	Rounded	
Payment and performance bond	3%	of subtotal		$ 1,600	Rounded	
Construction/program management	10%	of subtotal		$ 5,500	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 8,200	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 23,600		
SITE PREPARATION SUBTOTAL				$ 78,440		$ 78,440
CAP UPGRADE AND FIELD OVERSIGHT						
Heavy Equipment Rental for Installation of Cover						
Dozer	15	days	$ 325.00	$ 4,875	Hertz equipment rental	
Backhoe	10	days	$ 200.00	$ 2,000	Hertz equipment rental	
Roller/Compactor	10	days	$ 200.00	$ 2,000	Hertz equipment rental	
Dump Truck	15	days	$ 250.00	$ 3,750	Hertz equipment rental	
Pickup Trucks (2)	30	days	$ 80.00	$ 2,400	Hertz equipment rental	
Earthwork and Fencing						
Clay Layer (includes compaction)	4,530	CY	$ 28.00	$ 126,840	Professional estimate	
Clay volume assumes 9 inches of clay across cap to fill ruts and increase cap thickness by 6 inches.						
Top Soil	0	CY	$ 20.00	$ -	Professional estimate	
Quality Control Testing (includes compaction testing)	1	LS	$ 20,000.00	$ 20,000	Professional estimate	
Oyster Shells	570	tons	$ 15.00	$ 8,550	Professional estimate	
Assumes 25% of original oyster shell cover requires replacement.						
Hydroseeding	0	SF	$ 0.09	$ -	Professional estimate	
3-Strand Fence	1,540	LF	$ 4.50	$ 6,930	Professional estimate	
Double Gate	1	each	$ 250.00	$ 250	Professional estimate	
Subcontractor Labor						
Site superintendent	150	hrs	$ 110.00	$ 16,500	Professional estimate	
QA Officer	150	hrs	$ 110.00	$ 16,500	Professional estimate	
Operators (2)	250	hrs	$ 75.00	$ 18,750	Professional estimate	
Technicians (2)	250	hrs	$ 65.00	$ 16,250	Professional estimate	
Site Safety and Health Officer	150	hrs	$ 110.00	$ 16,500	Professional estimate	
Per Diem	15	days	$ 840.00	$ 12,600	Professional estimate	
SUBTOTAL				$ 274,695		
Professional Services, Project Management, and Fees						
Project management	5%	of subtotal		$ 13,700	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 8,200	Rounded	
Payment and performance bond	3%	of subtotal		$ 8,200	Rounded	
Construction/program management	10%	of subtotal		$ 27,500	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 41,200	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 98,800		
SOIL EXCAVATION, FIELD OVERSIGHT, TREATMENT AND BACKFILL SUBTOTAL				$ 373,495		$ 373,495
CAPITAL COST TOTAL				$ 488,135		$ 488,135

Table 3 - COST ESTIMATE - ALTERNATIVE # 2

Gulfco Marine Maintenance Superfund Site

Site: Gulfco Marine Maintenance
Location: Freeport, Brazoria County, Texas
Base Year: 2010
Date: January 14, 2011

Description: Perform Upgrade to the Cap. Includes 5 years cap maintenance.

Assumptions: Upgrades to the cap will include removing the approximately 0.5' layer of oyster shells on top of the cap, installing an additional 0.5- foot layer of clay material, placing 0.5' of oyster shells on cap and installing a 3-wire fence around former surface impoundment at toe.

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES	PRESENT VALUE AT 7%
ANNUAL CAP MAINTENANCE						
Subcontractor Costs						
Clay Repair	1	EA	$ 5,000.00	$ 5,000	Professional estimate	
Mowing	0	EA	$ 2,000.00	$ -	Professional estimate	
Subcontractor Labor						
Inspection	48	hrs	$ 110.00	$ 5,280	Professional estimate (6 inspections/yr at 8 hours each)	
Repair Oversight	30	hrs	$ 110.00	$ 3,300	Professional estimate (one repair per year at 30 hours)	
Per Diem	3	days	$ 840.00	$ 2,520		
SUBTOTAL				$ 16,100		
Professional Services, Project Management, and Fees						
Project management	5%	of subtotal		$ 800	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 500	Rounded	
Payment and performance bond	3%	of subtotal		$ 500	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 2,400	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 4,200		
ANNUAL CAP MAINTENANCE COST				$ 20,300		
ANNUAL CAP MAINTENANCE (Year 1)	1	LS	$ 20,300	$ **20,300**	Cap maintenance at 7% net present value	$ 20,300
ANNUAL CAP MAINTENANCE (Year 2)	1	LS	$ 20,300	$ **19,000**	Cap maintenance at 7% net present value	$ 19,000
ANNUAL CAP MAINTENANCE (Year 3)	1	LS	$ 20,300	$ **17,800**	Cap maintenance at 7% net present value	$ 17,800
ANNUAL CAP MAINTENANCE (Year 4)	1	LS	$ 20,300	$ **16,700**	Cap maintenance at 7% net present value	$ 16,700
ANNUAL CAP MAINTENANCE (Year 5)	1	LS	$ 20,300	$ **15,700**	Cap maintenance at 7% net present value	$ 15,700
TOTAL ESTIMATED COST					**ANNUALIZED COSTS**	$ **577,635**
					ROM ESTIMATE (-30%)	$ 404,300
					ROM ESTIMATE (+50%)	$ 866,500

Table 4 - COST ESTIMATE - ALTERNATIVE # 3

Gulfco Marine Maintenance Superfund Site

Site: Gulfco Marine Maintenance
Location: Freeport, Brazoria County, Texas
Base Year: 2010
Date: January 14, 2011

Description: Perform Upgrade to the Cap. Includes 5 years cap maintenance.

Assumptions: Upgrades to the cap will include removing the approximately 0.5' layer of oyster shells on top of the cap, installing an additional 0.5- foot layer of clay material, placing 1.5' of topsoil, hydroseeding and installing a 3-wire fence around former surface impoundment at toe.

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES	PRESENT VALUE AT 7%
CAPITAL COSTS						
REMEDIAL DESIGN						
Remedial Design						
Remedial Design	1	LS	$ 63,400	$ 63,400	Professional estimate (8% of Site Preparation and Cap Upgrade Construction)	
REMEDIAL DESIGN SUBTOTAL				$ 63,400		$ 63,400
SITE PREPARATION						
Site Prep						
Erosion Control Plan Development & Submittals	1	LS	$ 12,000	$ 12,000	Professional estimate	
Site Survey/Utility Locate	3	acres	$ 1,500	$ 4,500	RS Means *2005 Environmental Remediation Cost Data*	
Erosion Control Implementation - Silt Fencing	2,000	ft	$ 3.50	$ 7,000	Professional estimate	
Construct Decon Station for Trucks and Heavy Equipment	1	LS	$ 4,800	$ 4,800	Professional estimate	
Equipment Delivery	5	each	$ 300.00	$ 1,500	Professional estimate	
Miscellaneous Materials	1	each	$ 5,000	$ 5,000	Professional estimate	
Wheel Loader	3	days	$ 350	$ 1,050	Hertz equipment rental	
Pickup Trucks (2)	6	days	$ 80	$ 480	Professional estimate	
Labor						
Site Superintendent	30	hrs	$ 110	$ 3,300	Professional estimate	
QA Officer	30	hrs	$ 110	$ 3,300	Professional estimate	
Operator (2)	60	hrs	$ 75	$ 4,500	Professional estimate	
Technician	30	hrs	$ 65	$ 1,950	Professional estimate	
Site Safety and Health Officer	30	hrs	$ 110	$ 3,300	Professional estimate	
Per Diem	3	days	$ 720	$ 2,160	Professional estimate	
Site Prep Subtotal				$ 54,840		
Professional Services, Project Management, and Fees						
Legal Fees for Institutional Controls and Deed	1	LS	$ 4,000	$ 4,000		
Project management	5%	of subtotal		$ 2,700	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 1,600	Rounded	
Payment and performance bond	3%	of subtotal		$ 1,600	Rounded	
Construction/program management	10%	of subtotal		$ 5,500	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 8,200	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 23,600		
SITE PREPARATION SUBTOTAL				$ 78,440		$ 78,440
CAP UPGRADE AND FIELD OVERSIGHT						
Heavy Equipment Rental for Installation of Cover						
Dozer	25	days	$ 325.00	$ 8,125	Hertz equipment rental	
Backhoe	10	days	$ 200.00	$ 2,000	Hertz equipment rental	
Roller/Compactor	10	days	$ 200.00	$ 2,000	Hertz equipment rental	
Dump Truck	25	days	$ 250.00	$ 6,250	Hertz equipment rental	
Pickup Trucks (2)	50	days	$ 80.00	$ 4,000	Hertz equipment rental	
Earthwork and Fencing						
Clay Layer (includes compaction)	4,530	CY	$ 28.00	$ 126,840	Professional estimate	
Clay volume assumes 9 inches of clay across cap to fill ruts and increase cap thickness by 6 inches.						
Top Soil	9,060	CY	$ 20.00	$ 181,200	Professional estimate	
Quality Control Testing (includes compaction testing)	1	LS	$ 20,000.00	$ 20,000	Professional estimate	
Oyster Shells	0	CY	$ 12.50	$ -	Professional estimate	
Hydroseeding	163,000	SF	$ 0.09	$ 14,670	Professional estimate	
3-Strand Fence	1,540	LF	$ 4.50	$ 6,930	Professional estimate	
Double Gate	1	each	$ 250.00	$ 250	Professional estimate	
Subcontractor Labor						
Site superintendent	250	hrs	$ 110.00	$ 27,500	Professional estimate	
QA Officer	250	hrs	$ 110.00	$ 27,500	Professional estimate	
Operators (2)	350	hrs	$ 75.00	$ 26,250	Professional estimate	
Technicians (2)	350	hrs	$ 65.00	$ 22,750	Professional estimate	
Site Safety and Health Officer	250	hrs	$ 110.00	$ 27,500	Professional estimate	
Per Diem	25	days	$ 840.00	$ 21,000	Professional estimate	
SUBTOTAL				$ 524,765		
Professional Services, Project Management, and Fees						
Project management	5%	of subtotal		$ 26,200	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 15,700	Rounded	
Payment and performance bond	3%	of subtotal		$ 15,700	Rounded	
Construction/program management	10%	of subtotal		$ 52,500	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 78,700	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 188,800		
SOIL EXCAVATION, FIELD OVERSIGHT, TREATMENT AND BACKFILL SUBTOTAL				$ 713,565		$ 713,565
CAPITAL COST TOTAL				$ 855,405		$ 855,405

Table 4 - COST ESTIMATE - ALTERNATIVE # 3

Gulfco Marine Maintenance Superfund Site

Site: Gulfco Marine Maintenance
Location: Freeport, Brazoria County, Texas
Base Year: 2010
Date: January 14, 2011

Description: Perform Upgrade to the Cap. Includes 5 years cap maintenance.

Assumptions: Upgrades to the cap will include removing the approximately 0.5' layer of oyster shells on top of the cap, installing an additional 0.5- foot layer of clay material, placing 1.5' of topsoil, hydroseeding and installing a 3-wire fence around former surface impoundment at toe.

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES	PRESENT VALUE AT 7%
ANNUAL CAP MAINTENANCE						
Subcontractor Costs						
Clay Repair	1	EA	$ 5,000.00	$ 5,000	Professional estimate	
Mowing	2	EA	$ 2,000.00	$ 4,000	Professional estimate	
Subcontractor Labor						
Inspection	48	hrs	$ 110.00	$ 5,280	Professional estimate (6 inspections/yr at 8 hours each)	
Repair Oversight	30	hrs	$ 110.00	$ 3,300	Professional estimate (one repair per year at 30 hours)	
Per Diem	3	days	$ 840.00	$ 2,520		
SUBTOTAL				$ 20,100		
Professional Services, Project Management, and Fees						
Project management	5%	of subtotal		$ 1,000	Rounded	
Pollution Liability Insurance	3%	of subtotal		$ 600	Rounded	
Payment and performance bond	3%	of subtotal		$ 600	Rounded	
Undefined scope and market allowance	15%	of subtotal		$ 3,000	Rounded	
Professional Services, Project Management, and Fees Subtotal				$ 5,200		
ANNUAL CAP MAINTENANCE COST				$ 25,300		
ANNUAL CAP MAINTENANCE (Year 1)	1	LS	$ 25,300	$ **25,300**	Cap maintenance at 7% net present value	$ 25,300
ANNUAL CAP MAINTENANCE (Year 2)	1	LS	$ 25,300	$ **23,700**	Cap maintenance at 7% net present value	$ 23,700
ANNUAL CAP MAINTENANCE (Year 3)	1	LS	$ 25,300	$ **22,200**	Cap maintenance at 7% net present value	$ 22,200
ANNUAL CAP MAINTENANCE (Year 4)	1	LS	$ 25,300	$ **20,800**	Cap maintenance at 7% net present value	$ 20,800
ANNUAL CAP MAINTENANCE (Year 5)	1	LS	$ 25,300	$ **19,500**	Cap maintenance at 7% net present value	$ 19,500
TOTAL ESTIMATED COST					**ANNUALIZED COSTS**	$ **966,905**
					ROM ESTIMATE (-30%)	$ 676,800
					ROM ESTIMATE (+50%)	$ 1,450,400

Appendix A
Streamlined Ecological Risk Evaluation
EA – February 2011

Streamlined Ecological Risk Evaluation (SERE)

Non-Time Critical Removal Support
Gulfco Marine Maintenance Superfund Site
Freeport,Brazoria County, Texas
Contract No. EP-W-06-004
Task Order: 0067-NSEE-06JZ

Prepared for

U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202-2733

Prepared by

EA Engineering, Science, and Technology, Inc.
405 S. Highway 121
Building C, Suite 100
Lewisville, Texas 75067
(972) 315-3922

February 2011
Revision: 02
EA Project Number 14342.67

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LIST OF ACRONYMS AND ABBREVIATIONS

AST	Above Ground Storage Tank
AVS/SEM	Acid Volatile Sulfides/Simultaneously Extracted Metals
BCMCD	Brazoria County Mosquito Control Department
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
Chromalloy	Chromalloy American Corporation
COPEC	Constituent of Potential Ecological Concern
DDT	dichlorodiphenyltrichloroethane
DESR	Data Evaluation Summary Report
DOW	The DOW Chemical Company
DQO	Data Quality Objective
EA	EA Engineering, Science, and Technology, Inc.
EC20	Effects concentration 20 percent reduction
EPA	Environmental Protection Agency
ESV	Ecological Screening Value
Facts	Brazoria County Facts
FPSCR	Final Preliminary Site Characterization Report
FS	Feasibility Study
ft	feet
FWS	Fish & Wildlife Service
GRG	Gulfco Restoration Group
LC50	Lethal Concentration 50 percent
LDL	LDL Coastal Limited LP
μg/L	microgram per liter
mg/kg	milligram per kilogram
mg/L	milligram per liter
μmol/goc	micromole per gram organic carbon
NPL	National Priorities List
NTCRS	Non Time Critical Removal Support
OC	organic carbon
PAH	Polycyclic Aromatic Hydrocarbon
PBW	Pastor, Behling & Wheeler
PCA	Principal Components Analysis
PSCR	Preliminary Site Characterization Report
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SLERA	Screening Level Ecological Risk Assessment
SMDP	Scientific Management Decision Point
SOP	Standard Operating Procedure
TCEQ	Texas Commission of Environmental Quality
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Carbon

UAO	Unilateral Administrative Order
URS	URS Corporation

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) named the former site of Gulfco Marine Maintenance, Inc. in Freeport, Brazoria County, Texas (the site) to the National Priorities List (NPL) in May 2003. The EPA issued a modified Unilateral Administrative Order (UAO), effective July 29, 2005, which was subsequently amended effective January 31, 2008. The UAO required a Remedial Investigation (RI) and Feasibility Study (FS) be conducted for the site. As part of the RI/FS, a *Screening Level Ecological Risk Assessment* (SLERA) was prepared (Pastor, Behling & Wheeler [PBW] 2010a) on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow), collectively known as the Gulfco Restoration Group (GRG). The Scientific/Management Decision Point (SMDP) provided in the final SLERA concluded there was a potential for adverse ecological effects, and a more thorough assessment was warranted.

This document summarizes the site investigation activities and analysis that has been performed in accordance with the *Final Baseline Ecological Risk Assessment (BERA) Work Plan & Sampling and Analysis Plan (SAP)* (URS Corporation [URS] 2010b) and presents the assessment of ecological risk in the form of a Streamlined Ecological Risk Evaluation (SERE) for the Gulfco Marine Maintenance Superfund Site located in Freeport, Texas to assess if there is a need for a Non-Time Critical Removal at this Site north of Martin Avenue.

This SERE has been prepared using EPA guidance (EPA 1997; EPA 1998; EPA 1999) and the Texas Natural Resource Conservation Commission (TNRCC) guidance (TNRCC 2001).

1.1 SITE BACKGROUND

The site is located in Freeport, Texas at 906 Marlin Avenue (also referred to as County Road 756) (Figure 1). The site consists of approximately 40 acres along the north bank of the Intercoastal Waterway between Oyster Creek (approximately one mile to the east) and the Texas Highway 332 bridge (approximately one mile to the west). The site includes approximately 1,200 feet (ft) of shoreline on the Intercoastal Waterway, the third busiest shipping canal in the United States.

Marlin Avenue divides the site into two primary areas (Figure 2). For the purpose of descriptions in this report, Marlin Avenue is approximated to run due west to east. The property north of Marlin Avenue (the North Area) consists of undeveloped land and closed surface impoundments, while the property south of Marlin Avenue (the South Area) was developed for industrial uses with multiple structures, a dry dock, an above ground storage tank (AST) farm, and two barge slips connected to the Intercoastal Waterway. This SERE addresses only the area north of Martin Avenue.

Adjacent property to the north, west, and east of the North Area is undeveloped. Adjacent property to the east of the South Area is currently used for industrial purposes while to the west the property is currently vacant and previously served as a commercial marina. The Intercoastal Waterway bounds the South area to the south. Residential areas are located south of Marlin Avenue, approximately 300 ft west of the site, and 1,000 ft east of the site.

Some of the North Area is upland created from dredge spoil, but most of this area is considered wetlands, as per the U.S. Fish and Wildlife Service (FWS) Wetlands Inventory Map (FWS 2008). The most significant surface features in the North Area are two ponds (the Fresh Water Pond and the Small Pond) and the closed former surface impoundments (Figure 2). The former surface impoundments and the former parking area south of the impoundments and Marlin Avenue comprise the vast majority of the upland area within the North Area.

Field observations during the PRP RI indicate the North Area wetlands are irregularly flooded with nearly all of the wetland area inundated by surface water that can accumulate to a depth of one ft or more during extreme high tide conditions, storm surge events (such as hurricanes), and/or in conjunction with surface flooding of Oyster Creek located northeast of the site. Due to very low topographic slope and low permeability surface sediments, the wetlands are also very poorly draining and can retain surface water after major rainfall events.

During site reconnaissance performed by EA Engineering, Science, and Technology, Inc. (EA) on 15 December 2010 it was noted that the wetlands are part of the contiguous high marsh/salt pan area between the site and Oyster Creek. These wetland areas were inundated with water (surface to 4 cm below grade), and connecting ditches and the marsh pan held several centimeters of water (EA 2010b).

Under normal tide conditions and during periods of normal or below normal rainfall, standing water within the wetlands (outside of the two identified ponds discussed below) is typically more limited. Depending on rainfall and tide conditions, these areas can either be completely full of water or completely dry.

Water in the Fresh Water Pond is approximately 4 to 4.5 ft deep and is relatively brackish (PBW, 2009). This pond appears to be a borrow pit created by the excavation of soil and sediment as suggested by the well-defined pond boundaries and relatively stable water levels. Water levels in the Fresh Water Pond are not influenced by periodic extreme tidal fluctuations as the pond dikes preclude tidal floodwaters in the wetlands from entering the pond, except for during extreme storm surge events.

The small irregularly shaped area immediately north of the Fresh Water Pond (Figure 2) is a salt panne, a shallow depression that retains seawater for short periods of time such that salt accumulates to high levels over multiple tidal cycles.

The Small Pond is a very shallow depression located in the eastern corner of the North Area. The Small Pond is not influenced by daily tidal fluctuations and behaves in a manner consistent with the surrounding wetland (*i.e.*, becomes dry during dry weather, but retains water in response to and following rainfall and extreme tidal events). The Small Pond is also indicative of a salt panne.

Aerial spraying of the wetland areas north of Marlin Avenue, including the North Area, for mosquito control has historically been and continues to be performed by the Brazoria County Mosquito Control District and its predecessor agency, the Brazoria County Mosquito Control Department (both referred to hereafter as BCMCD). Aerial spraying for mosquito control has been performed from altitudes of 50 to 100 ft (Lake Jackson News 1957). Recently, BCMCD has been using Dibrom©, and organophosphate insecticide, with a diesel fuel carrier through a fogging atomizer application (Brazoria County Facts [Facts] 2006, 2008a, 2008b), as well as other compounds such as Scourge™, Kontrol 30-30, and Fyfanon® (personal communication between Gary Miller [EPA] and Fran Henderson [BCMCD 27 October 2010]). Truck-based spraying has also been performed along Marlin Avenue. Both types of spraying were observed during the performance of site RI activities by the PRP.

1.2 STREAMLINED ECOLOGICAL RISK EVALUATION PROCESS

In the superfund program, ecological risk is evaluated in an eight-step process, as defined in the Ecological Risk Assessment Guidance for Superfund (EPA 1977):

1) Screening Level Problem Formulation
2) Screening Level Exposure Estimate and Risk Calculation
3) BERA Problem Formulation
4) Study Design and Data Quality Objective Process
5) Field Sampling Plan Verification
6) Site Investigation and Data Analysis
7) Risk Characterization
8) Risk Management

The first two steps of the process were completed in the final PRP SLERA for the site (PBW 2010a). At the conclusion of the SLERA, the potential for adverse risk to several ecological receptors was determined and a SMPD was made to continue in the risk assessment process.

The third step in the process (BERA Problem Formulation) was completed for the site by the PRP in the *Final Baseline Ecological Risk Assessment Problem Formulation* (URS 2010a). In the problem formulation step, the list of constituents of potential ecological concern (COPEC) is further refined, contaminant fate and transport is evaluated, assessment endpoints, and a conceptual site model are defined, and questions of risk are developed.

The fourth and fifth steps in the BERA process were completed by the PRP in the *Final Baseline Ecological Risk Assessment Work Plan & SAP* (URS 2010b). In these steps, a work and sampling plan is developed for collecting additional media in support of the PRP BERA(in preparation) and the methods for evaluating the potential for risk at the site (*i.e.*, toxicity testing) are outlined. Data quality objectives (DQOs) are also defined in these steps. The PRP is in the process of completing the BERA (steps 6 through 8).

This document is a focused SERE, evaluating the need for a Non-Time Critical Removal at the Site north of Martin Avenue. As such, this document should not be considered as a formal part of the 8-step ecological risk assessment process discussed above but rather a limited and focused assessment of the wetlands north of Martin Avanue, to determine if sufficient risk is present to warrant a removal action. If the results of the SERE indicate a potential for ecological risk, a risk management decision is developed concerning what future actions, if any, may be warranted to manage that risk.

1.3 SCOPE OF DOCUMENT AND REPORT ORGANIZATION

Because there is no guidance for a focused SERE, this document follows the outline of the site investigation and analysis (Step 6) conducted in support of a BERA and the resulting risk characterization (Step 7) of the ecological risk process. Risks are estimated using both qualitative and quantitative methods (toxicity testing). The results of this SERE will support Step 8 (risk management) if needed. Possible decision outcomes from the SERE include:

- There is adequate information to conclude that no adverse ecological risk is present (i.e., risk is within acceptable limit and further evaluation is not needed)
- There is adequate information to conclude that adverse ecological risk is present and development of remedial alternatives is warranted (i.e., continue to Step 8)
- Available information is not adequate to estimate risk (i.e., data gaps are present)

Section 2 of this document provides a discussion of the site investigation activities that were completed in support of this SERE and outlined in the PRP's *Final Baseline Ecological Risk Assessment Work Plan & SAP* (URS 2010b). Section 3 summarizes the media concentrations and exposure point concentrations for site samples. Section 4 provides an analysis of the effects to ecological receptors. Section 5 provides the risk characterization. Section 6 provides a discussion of the uncertainties associated with the BERA, and Section 7 summarizes the conclusions of the SERE.

2.0 SITE INVESTIGATIONS IN SUPPORT OF THE PRP BERA

This section describes the data collected from North Area surface soil, wetland sediment and surface water samples, and used in this SERE. Sampling activities were conducted by the PRP between August 2010 and September 2010. The sample collection methods, analytical methods, and toxicity testing methods are described in the *Final BERA Work Plan & SAP* (URS 2010b) and summarized below. Overall, the data collected by the PRP in support of the BERA met the DQOs outlined in the *Final BERA Work Plan & SAP* (URS 2010b) and are adequate for evaluation and risk characterization used in this SERE.

2.1 TERRESTRIAL ENVIRONMENT

Investigation of site terrestrial areas was limited to the upland regions in the North Area including the former surface impoundments and the area south of the former impoundment. Soils in these areas likely became contaminated with COPECs due to surface runoff from the former surface impoundment area prior to capping. The final PRP SLERA identified potential risk to lower-trophic receptors such as soil invertebrates in these upland areas (PBW 2010a). Media collected in support of the PRP BERA included surface soils (0-6 inches below ground surface [bgs]), which represents the biologically active zone for soil-dwelling invertebrates. Toxicity tests were also conducted on surface soils to assess potential effects to these invertebrates. The analytical data for each sample are presented in Appendix A of the *Final Preliminary Site Characterization Report* (PSCR) (PBW 2010b) and summarized in Table 1.

2.1.1 North Area Surface Soil Sample Collection and Analysis

A total of six (6) surface soil samples were collected (0-6 inches bgs) from the North Area. Five (5) samples (NAS01 to NAS05) were collected in the area south of the former surface impoundment area, and one sample (NAS06) was collected in the northwest corner of the former surface impoundment area (Figure 3a). An additional three (3) samples were collected in the soil reference area approximately 2000 ft east of the site (Figure 3b). Analytical results are shown in Table 1.

All samples were analyzed for the following metals identified as COPECs in previous steps of the risk assessment process:

- Barium
- Chromium
- Copper, and
- Zinc

In addition, three of the six soil samples from the North Area (NAS02, NAS03, and NAS05) were analyzed for 4,4'- dichlorodiphenyltrichloroethane (DDT) and Aroclor-1254.

2.1.2 North Area Surface Soil Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted using the six surface soil samples collected from the North Area and the three reference samples to evaluate direct toxicity to soil-dwelling invertebrates. A 28-day earthworm (*Eisenia fetida*) chronic bioassay was originally proposed by the PRP in the *Final BERA Work Plan and SAP* (URS 2010b); however, elevated salinity in the surface soil samples made use of the earthworm problematic. When earthworms were introduced to the North Area soil samples there was an immediate avoidance reaction followed by acute mortality in all of the site and background samples. The elevated salinity levels are believed to be due to frequent inundation of estuarine during storm events. Also, much of the soil was originally dredge spoils from the Intercoastal Waterway, which was used as a fill material.

An alternative to the earthworm bioassays was developed following discussion and agreement by the EPA. This alternative treated the soils samples as sediments by adding synthetic seawater and exposing the marine polychaetous annelid, *Neanthes arenaceodentata*, to a 21-day bioassay to assess growth and survival. Polychaetes occupy a similar feeding guild to earthworms. The North Area soil toxicity testing was conducted from September 10 through October 1, 2010.

2.2 AQUATIC ENVIRONMENT

Sediments and surface water in the areas of the North area likely became contaminated with COPECs from direct discharge from barge cleaning operations, surface runoff, and flooding mechanisms. The final PRP SLERA identified potential risk to sediment and surface water dwelling invertebrates (PBW 2010a). Media collected in support of the PRP BERA included bulk sediments (0-6 inches bgs) and surface water from the North Area wetlands. Sediment pore water was also extracted from bulk sediments. Toxicity tests were conducted using wetland sediments and surface water to assess potential effects to sediment and surface water dwelling invertebrates. The analytical data for each sample are presented in Appendix A of the Final Preliminary Site Characterization Report (FPSCR) and summarized in Table 2 through Table 4.

2.2.1 North Area Wetland Bulk Sediment Sample Collection and Analysis

A total of seven (7) bulk sediment samples were collected by the PRP at depths of 0-6 inches bgs from the North Area wetlands. Five (5) samples (EWSED03 to EWSED07) were collected in the wetland areas south of the former surface impoundment area, and two samples (EWSED01 and EWSED02) were collected north of the Fresh Water Pond (Figure 4). An additional two (2) samples were collected in the sediment reference area north of the site and west of the former surface impoundments (Figure 4). Analytical results are shown in Table 2.

All samples were analyzed for the following parameters identified as COPECs in previous steps of the risk assessment process:

- Polycyclic Aromatic Hydrocarbons (PAHs): 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene
- Pesticides: 4,4'-DDT, endrin aldehyde, endrin ketone, gamma-chlordane
- Metals: arsenic, copper, lead, nickel, zinc
- Acid Volatile Sulfides/Simultaneously Extracted Metals (AVS/SEM)
- Grain size analysis

In addition to the bulk sediment samples, pore water was extracted and analyzed for COPECs for all but one sediment sample (EWSED05)(Table 3). This sample was too dry to extract pore water.

2.2.2 North Area Wetland Bulk Sediment Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted using the seven site sediment samples collected from the North Area and the two reference samples to evaluate direct toxicity to sediment-dwelling invertebrates. Two 28-day chronic bioassays were conducted using the amphipod, *Leptocheirus plumulosus*, and the polychaete, *N. arenaceodentata*. Both organisms were selected for toxicity testing because both are representative of common species found along the Texas gulf coast marshes, are sensitive to site COPECs, and are tolerant to a wide range of sediment and salinity conditions. Study endpoints of growth, mortality, and reproduction were measured for the *L. plumulosus* bioassay, while only the growth endpoint (with mortality data used to assist in the calculations) was used for the *N. arenaceodentata* bioassay.

2.2.3 North Area Wetland Surface Water Sample Collection and Analysis

A total of three (3) surface water samples were collected from the North Area wetlands. One sample (EWSW01) was collected in the area north of the Fresh Water pond. One sample

(EWSW03) was collected in the small, irregularly shaped waterbody south of the former surface impoundment, and one sample (EWSW04) was collected from the near the Small Pond (Figure 5). Surface water was not present at the reference location (EWSW02) and analysis and this location could not be performed. Analytical results are shown in Table 4.

All surface water samples were analyzed for the following parameters identified as COPECs in previous steps of the risk assessment process:

- Acrolein (EWSW01 only)
- Dissolved copper
- Dissolved nickel
- Dissolved silver
- Dissolved zinc

2.2.4 North Area Wetland Surface Water Toxicity Testing

Laboratory toxicity tests (bioassays) were conducted using the three site surface water samples collected from the North Area to evaluate direct toxicity to surface water-dwelling invertebrates. A 7-day chronic bioassay analysis that measured the survival and growth of the mysid shrimp, *Mysidopsis bahia,* was originally proposed in the *Final BERA Work Plan & SAP* (URS 2010b); however, elevated salinity in the surface water samples from the salt panne areas (40% salinity at EWSW01 and 39% at EWSW04) were outside the testing tolerances for this test organism.

An alternative to the mysid shrimp bioassays was developed following discussion and agreement by the EPA. This alternative used the brine shrimp (*Artemia salina*), which is better suited to testing at high salinities. No standards have been established for toxicity testing conducted on brine shrimp and a standard operating procedure (SOP) was developed by the analytical lab by referencing SOPs available for determining toxicity to produced (oil field) waters. The test protocol was shortened from 7 days to 96-hours and measured acute mortality of the organisms as the test endpoint. The shortened test period would likely be more representative of the intermittent nature of the surface water being evaluated in the North Area wetlands.

Surface water toxicity tests were conducted three times between September 16 and October 3, 2010.

3.0 EFFECTS ANALYSIS

This section presents effects analysis of the data collected through the supplemental sampling activities and toxicity testing of site media for the Gulfco site. This analysis evaluates the potential adverse impacts associated with COPCs and calculates effects concentration 20 percent reduction (EC20s), where relevant. The toxicity test reports are available in the *Final Preliminary Site Characterization Report (FPSCR)* (PBW 2010b). The independent evaluation by the EA project team is included in the Data Evaluation Summary Report (DESR) (EA 2010a).

3.1 TERRESTRIAL ENVIRONMENT

The following section discusses the comparison of soil analytical data to benchmarks and the results of the toxicity testing.

3.1.1 Comparison of North Area Surface Soil Concentrations to Literature-Based Ecological Screening Values (ESVs)

Table 1 provides a summary of the 2010 surface soil analytical results generated from implementation of the PRP BERA sampling plan. Table 1 also compares the Texas Commission of Environmental Quality (TCEQ) soil benchmarks to the 2010 North Area surface soil concentrations.

The 2010 surface soil data shows exceedances of soil benchmarks for barium, chromium, copper, and zinc. Barium (which ranges from 52.2 milligram per kilogram [mg/kg] to 502 mg/kg) exceeded the TCEQ soil benchmark of 300 mg/kg in one site location (NAS04) and one reference sample (NAS07). Chromium (which ranges from 7.86 mg/kg to 97.3 mg/kg) exceeded the TCEQ soil benchmark of 30 mg/kg in two site locations (NAS01 and NAS05). Copper (which ranges from 10.1 mg/kg to 221 mg/kg) exceeded the soil benchmark of 61 mg/kg at only one site location (NAS01). Zinc (which ranges from 62.3 mg/kg to 5770 mg/kg) exceeded the TCEQ soil benchmark of 120 mg/kg at five of the six site locations (NAS01 to NAS05) and two of the reference samples (NAS07 and NAS08).

TCEQ soil benchmarks were not available for the organics (4,4'-DDT and Aroclor-1254).

3.1.2 Results of the *N. arenaceodentata* Toxicity Tests

The results of the *N. arenaceodentata* toxicity tests are presented in Table 5 and summarized below from the PSCR (PBW 2010b). The testing of *N. arenaceodentata* over a 21-day exposure period showed no statistically significant difference between the North Area surface soil samples and the reference samples to the survival and growth endpoints for *N. arenaceodentata*. Survival of the six site samples ranged from 76 percent to 96 percent and the survival of the three reference samples ranged from 60 percent to 92 percent. Growth data show a similar relationship between the site and reference samples. The complete report for the 21-day *N. arenaceodentata* is presented in the PSCR (PBW 2010b).

In the evaluation, reference soils in NAS08 and NAS09 were pooled since they showed similar toxicological responses; however, reference soils at NAS07 were compared independently to site samples due to a significant difference at this location for both assessment endpoints. No site samples exhibited reduced survival to *N. arenaceodentata* when compared to either NAS07 or the pooled references consisting of NAS08 and NAS09. For the growth endpoint, however, growth at NAS01 was 57 percent lower than growth in reference NAS07 which is a statistically significant difference. The analytical results for NAS01 and the reference soils are provided on Figures 3a and 3b. No other site samples exhibited reduced growth when compared to NAS07. The output files for the analysis are presented in the DESR (EA 2010a).

3.2 AQUATIC ENVIRONMENT – NORTH AREA WETLANDS

The following section discusses the comparison of sediment and surface water analytical results to benchmarks and toxicity test results.

3.2.1 Comparison of Sediment and Pore Water Concentrations to Literature-Based ESVs

Table 2 summarizes the analytical results for the 2010 wetland sediment samples collected in support of the BERA. There were several exceedances of the sediment benchmarks for multiple individual PAHs (acenaphthene, acenaphthylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, phenanthrene, pyrene) and metals (lead, nickel, and zinc). Acenaphthene (which ranges from 0.0013 mg/kg to 0.075 mg/kg) exceeded the TCEQ sediment benchmark of 0.016 mg/kg in one site location (EWSED05). Acenaphthylene (which ranges from 0.0008 mg/kg to 0.057 mg/kg) exceeded the TCEQ sediment benchmark of 0.044 mg/kg in one site location (EWSED01). Benzo(a)pyrene (which ranges from 0.01 mg/kg to 0.79 mg/kg) exceeded the TCEQ sediment benchmark of 0.43 mg/kg in one site location (EWSED05). Chrysene (which ranges from 0.014 mg/kg to 0.77 mg/kg) exceeded the TCEQ sediment benchmark of 0.384 mg/kg in three site locations (EWSED01, EWSED02, and EWSED05). Dibenzo(a,h)anthracene (which ranges from 0.0026 mg/kg to 0.17 mg/kg) exceeded the TCEQ sediment benchmark of 0.0634 mg/kg in three site locations (EWSED01, EWSED02, and EWSED05). Fluoranthene (which ranges from 0.02 mg/kg to 1.3 mg/kg) exceeded the TCEQ sediment benchmark of 0.6 mg/kg in one site location (EWSED05). Phenanthrene (which ranges from 0.013 mg/kg to 0.78 mg/kg) exceeded the TCEQ sediment benchmark of 0.24 mg/kg in one site location (EWSED05). Pyrene (which ranges from 0.021 mg/kg to 1.1 mg/kg) exceeded the TCEQ sediment benchmark of 0.665 mg/kg in one site location (EWSED05). Lead (which ranges from 12 mg/kg to 76.1 mg/kg) exceeded the TCEQ sediment benchmark of 46.7 mg/kg in two site locations (EWSED03 and EWSED05). Nickel (which ranges from 14.4 mg/kg to 22.5 mg/kg) exceeded the TCEQ sediment benchmark of 20.9 mg/kg in two site locations (EWSED03 and EWSED05). Zinc (which ranges from 70.1 mg/kg to 959 mg/kg) exceeded the TCEQ sediment benchmark of 150 mg/kg in four site locations (EWSED03 to EWSED06).

Analytical results for additional parameters including grain size analysis and SEM/AVS are also presented in Table 2. The SEM/AVS ratios are all above 1.0, except EWSED08 (SEM/AVS ratio of 0.157). Sediment grain sizes are fairly consistent between locations, except for the relatively high fraction of gravel and low fraction of clay found at EWSED02 and EWSED03, which is the opposite of the typical sediment profile (i.e., low fraction of gravel and high fraction of clay).

Table 3 summarizes the analytical results for the 2010 sediment pore water samples. The only exceedances of surface water benchmarks from site sediment pore water samples were for endrin aldehyde, endrin ketone, copper, and zinc. Endrin aldehyde (which ranges from <0.00000046 milligrams per liter [mg/L] to 0.000015 mg/L) exceeded the TCEQ surface water benchmark of 0.000002 mg/L in three site locations (EWSED01 to EWSED03). Endrin ketone (which ranges from <0.00000066 mg/L to 0.000007 mg/L) exceeded the TCEQ surface water benchmark of 0.000002 mg/L in one site location (EWSED03). Copper (which ranges from <0.000342 mg/L to 0.00702 mg/L) exceeded the TCEQ surface water benchmark of 0.0036 mg/L in two site locations (EWSED03 and EWSED05). Zinc (which ranges from <0.00135 mg/L to 0.626 mg/L) exceeded the TCEQ surface water benchmark of 0.0842 mg/L in two site locations (EWSED04 and EWSED06).

The only exceedances of either sediment or surface water benchmarks in the background samples were 4,4'-DDT in sediment and 4,4'-DDT, endrin aldehyde, and nickel in pore water.

3.2.2 Results of the *N. arenaceodentata* Toxicity Tests

The results of the *N. arenaceodentata* toxicity tests are presented in Table 5 and summarized below from the PSCR (PBW 2010b). For *N. arenaceodentata* and the survival endpoint there were no statistically significant differences between the seven site samples and the two reference samples. Survival rates ranged from 72 percent to 96 percent in site samples and 68 percent to 76 percent in the reference samples. For the primary growth endpoint, there were also no statistical differences between the seven site samples and the two reference samples (PBW 2010b).

In the evaluation, reference soils in NAS08 and NAS09 were pooled since they showed similar toxicological responses. No Site samples exhibited reduced survival or growth to *N. arenaceodentata* when compared to the pooled references consisting of NAS08 and NAS09. The output files for the analysis are presented in the DESR (EA 2010a).

3.2.3 Results of the *L. plumulosus* Toxicity Tests

For the amphipod *L. plumulosus*, there were no statistical differences between the seven site samples and the two reference samples for either the survival or growth endpoint. Survival rates ranged from 13 percent to 58 percent in site samples and between 19 percent and 33 percent in reference samples (Table 5). There were insufficient offspring available for statistical analysis of reproduction as an endpoint.

In the evaluation, reference soils in NAS08 and NAS09 were pooled since they showed similar toxicological responses. Site samples did not exhibit significantly reduced survival when compared to the pooled reference data set.

Growth was lower in sample EWSED06 when compared with the pooled reference data set. The magnitude of the reduced growth was 74 percent in EWSED06. The output files for the analysis are presented in the DESR (EA 2010a).

3.2.4 Comparison of Wetland Surface Water Concentrations to Literature-Based ESVs

Table 4 provides a summary of the 2010 wetland surface water samples collected in support of the PRP BERA and includes the TCEQ surface water benchmarks. The only exceedance of a surface water benchmark was for dissolved copper at EWSW03. The background location (EWSW02) could not be sampled for surface water during the 2010 sampling event as this area was dry.

3.2.5 Results of the *A. salina* Toxicity Tests

The results of the *A. salina* toxicity tests are presented in Table 7 and summarized below from the FPSCR (PBW 2010b). The surface water toxicity tests were conducted three times between September 16 and October 3, 2010. EWSW01 and EWSW04 showed no evidence of acute toxicity since survival in the undiluted samples were greater than or equal to 80 percent for all test durations where the corresponding control survival was greater than or equal to 90 percent. EWSW03 was found to be non-toxic in test runs 1 and 2 (survival in the undiluted sample was greater than or equal to 80 percent for all test durations where the corresponding control survival was greater than or equal to 90 percent. In test run 3, a concentration-related mortality response was observed for EWSW03. The corresponding medial lethal concentrations are as follows:

- 24 hour = 30.7 percent
- 48 hour = 10.6 percent
- 72 hour = 6.2 percent

While the mortality response for EWSW03 in test run 3 is consistent with the detection of copper at a concentration above the TCEQ chronic surface water benchmark (0.00854 mg/L vs. 0.00360 mg/L), the magnitude of the exceedance is not consistent with the observed mortality in test run 3, and is not consistent with the absence of toxicity in the first two runs (PBW 2010b). The TCEQ acute and chronic freshwater values at a hardness of 237mg/L (Oyster Creek USGS,1998) would be 0.032mg/L and 0.0198mg/L respectively.

The evaluation included an independent review of the results for run 3 for all samples, which exhibited an acceptable control survival for 72 hours. By relevant test method guidance (EPA 2002), the Probit Method is the preferred procedure for determining the lethal concentration 50 percent (LC50) if the data passes the chi-square test. The Probit Method was appropriate for the data from these tests, and was used in the analysis. The results were generally consistent with those presented in the FPSCR (PBW 2010b):

- Samples EWSW01 and 4 did not exhibit acute toxicity (LC50 > 100 percent)
- Sample EWSW03 had an LC50 at 6 percent dilution

The analytical results of at sample EWSW03 (the only place to indicate toxicity) are shown on Figure 5 and in Table 4.

3.3 SUMMARY

In the analysis of North Area surface soils, where reference samples were pooled for NAS08 and NAS09 and evaluated independently of reference sample NAS07, site sample NAS01 exhibited reduced growth of *N. arenaceodentata* when compared with reference sample NAS07.

When assessing survival and growth in the polychaete, *N. arenaceodentata,* and the amphipod, *L. plumulosus,* where reference samples were pooled, wetland sediment EWSED06 exhibited significantly reduced growth of *L. plumulosus* when compared with wetland sediment reference samples.

In the analysis, using pooled reference data to evaluate the results of the acute toxicity tests of three surface water samples to brine shrimp (*A. salina*), Samples EWSW01 and EWSE04 did not exhibit acute toxicity (LC50 > 100 percent), and Sample EWSW03 had an LC50 between 5 and 6 percent dilution.

4.0 RISK CHARACTERIZATION

This section serves to analyze the data presented to this point in the SERE and provide an estimate of risk to the identified receptors in the North Area terrestrial environment and the aquatic environments located in the North Area. The risk characterization process will help address the ecological risk questions posed in the *Final BERA Work Plan & SAP (URS 2010b)*:

1) Does direct exposure to COPECs in surface soil adversely affect the abundance, diversity, productivity, and function of the soil invertebrate community?
2) Does direct exposure to COPECs in bulk sediments and pore water adversely affect the abundance, diversity, productivity, and function of benthic invertebrates?
3) Does direct exposure to COPECs in surface water adversely affect the abundance, diversity, productivity, and function of the fish community?

Addressing these assessment endpoints will assist in answering the risk management decision regarding the need for a non-time critical removal action in the north area of the Site.

4.1 IDENTIFICATION OF POTENTIAL STRESSORS

One step in characterizing risk is the identification of potential stressors in each ecological area where toxicity is observed. Initial steps in this dose-response evaluation uses techniques that are occasionally referred to as "data mining" techniques intended to identify relationships between parameters. Procedures used included development of correlation matrices and Principal Components Analysis (PCA). Upon review of findings of these statistical procedures, the concentrations of a selected number of indicator chemicals that are significantly associated with a 20 percent reduction in measurement endpoints (effects concentration 20 percent reduction, or EC20) were estimated. EC20s were estimated by the smoothed linear interpolation procedure recommended by relevant EPA test methods (see for example, EPA 2000, Section 16.2.5.7).

It is generally true that statistical associations are not conclusive regarding cause and effect. Because many of the chemicals are significantly correlated with other chemicals in the samples, the ability to conclude cause and effect from the statistical analyses is difficult. A subset of chemicals with the strongest statistical association with adverse effects was selected as indicator chemicals for estimation of EC20s. It is possible that these chemicals are not the cause of the adverse effect; adverse effects may actually be caused by one or more other chemicals that are correlated with the indicator chemicals. Nonetheless, the indicator chemicals selected have the strongest association with the adverse effects, and may be used to identify sediments that are likely to impair the identified ecological receptors.

Parameters evaluated included concentration of chemicals in bulk sediment, concentrations of organic chemicals normalized by the organic carbon (OC) content of the sediments/soils, concentrations of chemicals in pore water, ΣSEM/AVS, (ΣSEM-AVS)/Total Organic Carbon (TOC), OC, and grain size (indicated by percent gravel, sand, silt, and clay).

The PCA procedure was implemented using SYSTAT 11 (SYSTAT Software, Inc. 2004). Two factors were sought. The first factor is a linear combination of the chemical concentrations that explains the largest portion of the variance in the concentration data. The second factor is orthogonal (not correlated) to the first and explains as much of the remaining variance in the data as possible. The results of this correlation analysis is provided in the DESR (EA 2010a).

4.2 DIRECT EXPOSURE OF SOIL INVERTEBRATES

The potential for adverse effects to the soil invertebrate community were evaluated primarily through comparison of COPEC concentrations in North Area surface soils to literature-based benchmarks and the 21-day bioassay results of *N. arenaceodentata*.

4.2.1 Comparison of North Area Surface Soils to Literature-Based Benchmarks

Only barium, chromium, copper, and zinc exceeded soil benchmarks. Exceedances of these benchmarks were limited to three site samples except zinc, which was present in five of six site samples. Only barium and zinc were present above screening levels in the reference area soils. While comparison to literature-based benchmarks can be a tool for assessing risk, this method has the highest uncertainty and lowest confidence because they are not site-specific toxicity values.

4.2.2 *N. arenaceodentata* Toxicity Testing and Identification Potential Stressors

The evaluation of toxicity testing results for this receptor indicates the potential for reduced growth of *N. arenaceodentata* at NAS01, which had the highest metals concentrations, when compared with reference sample NAS07. A limited number of potential stressors were quantified in the North Area Soils exposure area. These were barium, chromium, copper, and zinc. Chromium, copper, and zinc were significantly correlated with each other (co-located), while barium was not associated with the other metals analyzed. As discussed in the DESR, chromium, copper, and zinc also appeared to be negatively associated with *N. arenaceodentata* growth, however the apparent relationships were not significant at the 0.10 level of significance, and were not investigated further (EA 2010a).

4.3 DIRECT EXPOSURE OF BENTHIC INVERTEBRATES IN WETLANDS SEDIMENTS

The potential for adverse effects to the benthic invertebrate community were evaluated primarily through comparison of COPEC concentrations in North Area sediments to literature-based benchmarks and the bioassay results of *N. arenaceodentata* and *L. plumulosus*.

4.3.1 Comparison of North Area Sediments to Literature-Based Benchmarks

Multiple PAHs and several metals exceeded sediment benchmarks. Exceedances of these benchmarks were limited in number for most COPECs (one to three samples at the most) and exceedances were typically within the same order of magnitude as the benchmark concentrations. The exception to this was zinc, which was present in four of the seven site samples. While comparison to literature-based benchmarks can be a tool for assessing risk, this method has the highest uncertainty and lowest confidence because they are not site-specific toxicity values.

4.3.2 *N. arenaceodentata* and *L. plumulosus* Toxicity Testing and Identification of Potential Stressors.

In the hypothesis analysis, where reference samples were pooled, wetland sediment EWSED06 exhibited reduced growth of *L. plumulosus* when compared with wetland sediment reference samples. No statistical difference was observed between wetland sediment samples and reference sediment samples when assessing survival and growth in the polychaete *N. arenaceodentata*.

Exploratory correlation and PCA revealed that, although PAH compounds were strongly correlated with each other (co-located) they were not closely associated with the toxic endpoint (*L. plumulosus* growth) (EA 2010a). To reduce the number of variables considered in the analysis, Total PAHs and Σ(PAHs/TOC) were determined, and individual PAH compounds were eliminated from the data set.

Correlation analysis showed that sediment grain size was not significantly associated with *Leptocheirus* growth, while zinc in bulk sediment, (ΣSEM-AVS)/TOC, and copper in pore water were negatively associated (i.e. as one goes up the other goes down) with *Leptocheirus* growth (EA 2010a). Significant association is indicated at the 0.05 level of significance.

Pore water was not analyzed in all the samples that were analyzed for bulk sediment chemistry and AVS/SEM. Therefore, the correlation analysis was performed separately (EA 2010a). Copper was the only pore water analyte that was significantly associated with adverse effects to *L. plumulosus* growth at the 0.05 level of significance.

As a result of these analyses, the following analytes appear to be associated with the observed growth effects to *L. plumulosus* in wetland sediments:

- Copper (pore water)
- Zinc (bulk sediment)

- (ΣSEM-AVS)/TOC

Correlation matrices for *L. plumulosus* endpoints versus bulk sediment chemistry and pore water chemistry are included in DESR (EA 2010a).

4.4 DIRECT EXPOSURE OF AQUATIC ORGANISMS IN NORTH AREA SURFACE WATER

The potential for adverse effects to the aquatic organisms were evaluated primarily through comparison of COPEC concentrations in North Area surface water to literature-based benchmarks and the bioassay results of *A.salina*.

4.4.1 Comparison of North Area Sediments to Literature-Based Benchmarks

The only exceedance of a surface water benchmark was for dissolved copper at EWSW03. Comparison to background levels was not available for surface water. While comparison to literature-based benchmarks can be a tool for assessing risk, this method has the highest uncertainty and lowest confidence because they are not site-specific toxicity values.

4.4.2 *A. salina* Toxicity Testing and Identification of Potential Stressors

The results of the acute toxicity tests of three surface water samples to brine shrimp (*A. salina*) were generally consistent between the original analysis presented in the FPSCR and the analysis using pooled reference data: Samples EWSW01 and EWSW04 did not exhibit acute toxicity (LC50 > 100 percent), and Sample EWSW03 had an LC50 between 5 and 6 percent dilution.

Acute toxicity to *A. salina* was indicated in 1 of 3 samples (EWSW03). These samples were analyzed for copper, nickel, silver, and zinc to aid in the determination of potential stressors. The data set is too small for quantitative statistical evaluation; however, concentrations of copper (8.54 microgram per liter [μg/L]) and silver (0.049 μg/L) are greater in the sample that exhibited acute toxicity to brine shrimp than in the other samples. If toxicity is attributable to copper, it appears that concentrations less than 3.4 μg/L would not cause toxicity to *A. salina.*

5.0 UNCERTAINTY

Uncertainty exists in many areas of risk assessment. The nature of the uncertainties depends on the data available, the degree of knowledge of site conditions, and the assumption made throughout the risk assessment process. Site-specific uncertainties inherent in the SERE are provided below:

- Toxicity to soil dwelling invertebrates was assessed using site toxicity data from *N. arenaceodentata*, a sediment dwelling marine polychaete, due to the high salinity of surface soils in the North Area. Site soils were submerged with synthetic seawater for the toxicity tests. The treatment of surface soils as sediments and the use of a marine invertebrate may over- or underestimate risk to soil-dwelling invertebrates present in the North Area terrestrial environment.

- Site media concentrations were compared to literature-based benchmarks, or ESVs, which are not site-specific. This may over or underestimate risk.
- Toxicity to surface water dwelling invertebrates was assessed using site toxicity test data for the brine shrimp, *A. salina*, for which no established SOP was available. Multiple runs of the surface water toxicity tests were required due to potential feeding issues of test organisms and repeated control failure. Surface water reference data was also not available due to dry conditions in the reference area for comparison to toxicity test results. These factors may over- or underestimate risk to surface water-dwelling invertebrates present in the North Area aquatic environment.
- The results of the toxicity studies are not always well correlated to the results of the analytical chemistry. For example, while reference samples were elevated in soil sample NAS07, the survival of *N. arenaceodentata* in that sample was high (92 percent). Contrastingly, reference concentrations of all metal COPECs were below the TCEQ soil benchmarks at sample location NAS09, yet this sample indicated the highest mortality (60 percent). Factors other than site COPECs may explain the observed toxicity. This could over- or underestimate risk.
- The use of synthetic seawater to treat the soils as sediments for the toxicity test could also over or underestimate risks.
- SEM/AVS ratios for wetland sediments are generally above 1.0, indicating that conditions do not highly favor the formation of metal sulfides making them less bioavailable. The ratio of "excess" SEM to the fraction OC content in sediment is below 130 micromoles per gram organic carbon (μmol/goc) which is the concentration predicted to be non-toxic by the EPA (EPA, 2005) for six of the seven site samples. This may overestimate risk to metals from wetland sediments.
- The differences in how hypothesis testing were performed resulted different outcomes for wetland sediment and surface soils. This may over- or underestimate risk.

6.0 CONCLUSIONS

This SERE focused on characterizing potential risk from surface soils, sediments, and surface waters in the North Area. Potential risk was evaluated through the additional data analysis.

Toxicity tests of North Area surface soils to soil invertebrates, represented by the marine polychaete, *N. arenaceodentata,* indicated a significant difference for growth at one sampling location. Toxicity tests of wetland sediments to sediment dwelling invertebrates, represented by the amphipod, *L. plumulosus,* indicated significant difference in growth at one location. No significant differences were observed for survival and growth of N. *arenaceodentata* for the North Area sediment. Acute toxicity to the brine shrimp, *A. salina,* was indicated in one surface water sample from the North Area.

While the results of the site-specific toxicity test indicate the potential for some adverse effects to benthic invertebrates, risk is likely overestimated due to the intermittent nature of surface water in the wetlands. Depending on rainfall and tide conditions, many of the areas selected for sediment toxicity analysis can often be completely dry. Significant populations of invertebrates would likely be limited to areas with perennial surface water. While individual effects may be present, it is unlikely that population level effects to growth and survival of invertebrates exist from COPECs in site surface soils, sediments and surface waters.

These findings are similar to those of the EA *Technical Memorandum Ecological and Habitat Health Assessment, Wetlands A, B, and C* (EA 2010b) which indicated that observed human impacts to the Site wetland habitats are minor. The Site wetlands are not visually distinguishable from surrounding wetlands in terms of wetland species composition and approximate density, presence of invertebrates, and wildlife usage. These wetlands are providing valuable wetland marsh functions, such as wildlife habitat, food, flood storage, water quality enhancement, and groundwater recharge. Any disturbance, such as excavation of sediments or other remedial activities, would require decades for sediments in this area to return to the salty sediment marsh type environment present today.

REFERENCES

Brazoria County Facts. 2006. "Pilots Take to Skies to Eradiate Mosquitoes." June 16.

Brazoria County Facts . 2008a. "County District Responds to Mosquito Outbreak." September 8.

Brazoria County Facts . 2008b. "State Adds to Mosquito-Spraying Efforts." September 26.

EA Engineering, Science, and Technology, Inc. (EA). 2010a. *Data Evaluation Summary Report for the Baseline Ecological Risk Assessment, Gulfco Marine Maintenance Superfund Site, Freeport, Brazoria County, Texas.* December 27.

EA. 2010b. *Technical Memorandum Ecological and Habitat Health Assessment, Wetlands A, B, and C, Gulfco Marine Maintenance Superfund Site, Freeport, Texas.* December.

U.S. Environmental Protection Agency (EPA). 1997. *Ecological risk assessment guidance for Superfund: process for designing and conducting ecological risk assessments.* Interim Final. EPA/540/R-97/006.

EPA. 1998. *Guidelines for Ecological Risk Assessment. Risk Assessment Forum.* EPA/630/R-95/002F. April 1998

EPA. 1999. *Supplemental Guidance to RAGs: Region 4 Bulletins, Ecological Risk Assessment.* Originally published November 1995. Website version last updated November 30, 2001.

EPA. 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates.* Second Edition. EPA-600-R-99-064.

EPA. 2002. *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms.* Fifth Edition. EPA-821-R-02-012.

EPA. 2005. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc.* Office of Research and Development. EPA-600-R-02-011.

U.S. Fish and Wildlife Service (FWS). 2008. *National Wetlands Inventory, Online Wetlands Mapper.* http://wetlandsfws.er.usgs.gov/wtlnds/launch.html. Accessed July 9, 2008.

Lake Jackson News. 1957. "Spray Plane Swats Mosquito via Two Day Oil Spray Job." August 8.

Pastor, Behling & Wheeler, LLC (PBW). 2009. *Nature and Extent Data Report, Gulfco Marine Maintenance Site, Freeport, Texas.* May 3.

PBW. 2010a. *Final Screening Level Ecological Risk Assessment Report, Gulfco Marine Maintenance Site, Freeport, Texas.* May 3.

PBW. 2010b. *Preliminary Site Characterization Report (PSCR), Gulfco Marine Maintenance Site, Freeport, Texas*. November 3.

Personal communication between Gary Miller (EPA) and Fran Henderson (BCMCD), 27 October 2010.

Texas Natural Resource Conservation Commission (TNRCC). 2001. *Guidance for Conducting Ecological Risk Assessments at Remediation Sites in Texas*, Toxicology and Risk Assessment Section. RG-263 (revised). December.

URS Corporation (URS). 2010a. *Final Baseline Ecological Risk Assessment Problem Formulation Report, Gulfco Marine Maintenance Site*, Freeport, Texas. September 2.

URS. 2010b. *Final Baseline Ecological Risk Assessment Work Plan & Sampling and Analysis Plan, Gulfco Marine Maintenance Site*, Freeport, Texas. September 2.

TABLES

TABLE 1

DATA SUMMARY FOR NORTH AREA SURFACE SOILS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Location	Comments	4,4'-DDT	Aroclor-1254	Barium	Chromium	Copper	Zinc
TCEQ Soil Benchmark			*NA*	*NA*	*300*	*30*	*61*	*120*
NAS01	North Area Soil				272	**97.3**	**221**	**5770**
NAS02	North Area Soil		0.0075 J	0.093 J	163	27.2	26.0	**296** JH
NAS02DUP	North Area Soil		0.015 J	0.16 J	261	23.1	24.9	**307** J
NAS03	North Area Soil		0.0078	--	190	15.4	22.9	**307** J
NAS04	North Area Soil		--	0.01	**502**	7.86	10.8	**321** J
NAS05	North Area Soil		0.008	--	198	**30.9**	27.4	**309** J
NAS06	North Area Soil		--	--	52.2	13.4	10.8	62.3 J
NAS07	North Area Soil	Background location BSS-01	--	--	**340**	12.4	10.1	**501**
NAS08	North Area Soil	Background location BSS-02	--	--	182	13.6	12.6	**182**
NAS09	North Area Soil	Background location BSS-03	--	--	172	13.3	11.0	63.1

Notes:
Values in mg/kg, dry weight
J = Estimated Concentration
H = Concentratin Biased High
mg/kg = milligrams per kilograms
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 2

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Location	Date	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene
TCEQ Marine Sediment Benchmark	--	--	*0.07*	*0.016*	*0.044*	*0.0853*
EWSED01	Wetland	8/12/2010	0.0038 J	0.0046 J	**0.057**	0.043
EWSED02	Wetland	8/12/2010	0.002 J	0.0018 J	0.041	0.032
EWSED02DUP	Wetland	8/12/2010	**0.0026** J	0.0013 J	0.03	0.024
EWSED03	Wetland	8/13/2010	**0.0068**	0.0043 J	0.0032 J	0.005
EWSED04	Wetland	8/13/2010	0.0037 J	0.0026 J	0.0069	0.006
EWSED05	Wetland	8/12/2010	**0.02**	**0.075**	0.018	0.078
EWSED06	Wetland	8/12/2010	0.0016 J	0.0013 J	0.0008 J	0.0011 J
EWSED07	Wetland	8/13/2010	**0.0053**	0.009	0.0091	0.027
EWSED08	Wetland	8/13/2010	0.001 J	< 0.00088	< 0.00069	0.001 J
EWSED09	Wetland	8/13/2010	0.00061 J	< 0.00076	< 0.00059	< 0.00058

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

TABLE 2

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Arsenic	SEM/AVS	Benzo(a)pyrene	Benzo(g,h,i)perylene	Copper	Indeno(1,2,3-cd)pyrene
TCEQ Marine Sediment Benchmark	*8.2*	*NA*	*0.43*	*NA*	*34*	*NA*
EWSED01	2.97	0.089	0.24	0.63	20.6	0.22
EWSED02	2.4	0.014	0.12	0.46	13.3	0.18
EWSED02DUP	2.51	--	0.097	0.35	14.6	0.16
EWSED03	5.36	0.002	0.028	0.058	25	0.034
EWSED04	4.35	0.039	0.04	0.076	20.3	0.064
EWSED05	3.06	0.002	**0.79**	0.68	28.9	0.79
EWSED06	3.23	0.084	0.01	0.019	28.1	0.019
EWSED07	5.94	0.005	0.087	0.1	30.7	0.1
EWSED08	2.92	6.4	0.014	0.017	15.8	0.019
EWSED09	2.58	0.062	0.0027 J	0.0032 J	11.7	0.0032 J

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

TABLE 2

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Lead	Nickel	4,4'-DDT	Endrin Aldehyde	Benzo(a)anthracene	Endrin ketone
TCEQ Marine Sediment Benchmark	*46.7*	*20.9*	*0.00119*	*NA*	*0.261*	*NA*
EWSED01	17.2	18.9	< 0.001 J	0.0007 J	< 0.066 J	< 0.000093
EWSED02	12	15.6	< 0.00017	< 0.00012	< 0.043 J	< 0.000093
EWSED02DUP	14.7	17.3	< 0.00017	< 0.001 J	< 0.00072 J	< 0.0011 J
EWSED03	**48.4**	**21.7**	**0.0028**	0.00027 J	0.024	< 0.00011 J
EWSED04	37.4	16.9	--	--	0.031	--
EWSED05	**76.1**	14.4	< 0.019 J	0.0014 J	**0.55**	< 0.001 J
EWSED06	32.9	**22.5**	**0.0012**	< 0.00012	0.0069	< 0.000093
EWSED07	32.7	20.1	--	--	0.09	--
EWSED08	19.8	16.3	**0.0014**	0.00052 J	0.011	< 0.00012
EWSED09	17.4	16.5	**0.0016**	< 0.00012	0.0024 J	< 0.000093

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Chrysene	gamma-Chlordane	Dibenz(a,h)anthracene	Flourene	Flouranthene
TCEQ Marine Sediment Benchmark	*0.384*	*0.00226*	*0.0634*	*0.019*	*0.6*
EWSED01	**0.39**	< 0.00009	**0.17**	0.019	0.038
EWSED02	**0.62**	< 0.00009	**0.11**	0.013	0.023
EWSED02DUP	**0.49**	< 0.00009	**0.094**	0.011	0.019
EWSED03	0.064	< 0.00009	0.0074	0.0048	0.052
EWSED04	0.05	--	0.01	0.0032 J	0.076
EWSED05	**0.77**	< 0.00009	**0.14**	**0.065**	**1.3**
EWSED06	0.014	0.00025 J	0.0026 J	0.001 J	0.02
EWSED07	0.14	--	0.019	0.016	0.26
EWSED08	0.017	< 0.00012 J	0.003 J	0.00092 J	0.031
EWSED09	0.004	< 0.00023 J	< 0.0008	< 0.00061	0.0055

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	Phenanthrene	Pyrene	Total Organic Carbon	Zinc	GRAVEL, MEDIUM,%	GRAVEL, FINE,%
TCEQ Marine Sediment Benchmark	*0.24*	*0.665*	*NA*	*150*	*NA*	*NA*
EWSED01	0.032	0.091	59400	115	2.52	3.49
EWSED02	0.016	0.14	24100	70.1	53.7	5.66
EWSED02DUP	0.014	0.11	30500	86.1	--	--
EWSED03	0.049	0.069	18200	**585**	47.9	7.73
EWSED04	0.041	0.075	16700	**417**	0.57	2.19
EWSED05	**0.78**	**1.1**	18100	**595**	0.34	2.64
EWSED06	0.013	0.021	21500	**959**	18.7	0.87
EWSED07	0.15	0.19	23900	**318**	--	--
EWSED08	0.015	0.027	46800	94.3	12.7	12.1
EWSED09	0.0024 J	0.0044 J	11200	88.3	1.97	2.31

Notes:
Values in mg/kg. dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

TABLE 2

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS

GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	**SAND, VERY COARSE,%**	**SAND, COURSE,%**	**SAND, MEDIUM,%**	**SAND, FINE,%**	**SAND, VERY FINE,%**	**SILT,%**	**CLAY,%**
TCEQ Marine Sediment Benchmark	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
EWSED01	5.58	2.82	1.8	2.12	2.42	61.6	21.2
EWSED02	2.91	1.77	1.15	2.29	1.64	13.7	10.8
EWSED02DUP	--	--	--	--	--	--	--
EWSED03	4.83	3.01	1.75	1.93	0.93	29.2	1.7
EWSED04	2.88	3.18	2.98	7.02	4.59	81.4	0.6
EWSED05	2.83	4.49	4.93	8.91	6.96	38.7	27.5
EWSED06	0.67	0.41	0.27	2.06	1.24	21.6	61.7
EWSED07	--	--	--	--	--	--	--
EWSED08	8.04	3.92	1.93	2.62	2.51	44.3	14.6
EWSED09	1.35	0.54	0.4	1.87	5.24	40.4	48.5

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

TABLE 2

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	**Acid-volatile sulfide, µmol/gsed**	**Cadmium, SEM, µmol/gsed**	**Copper, SEM, µmol/gsed**	**Lead, SEM, µmol/gsed**	**Nickel, SEM, µmol/gsed**	**Zinc, SEM, µmol/gsed**
TCEQ Marine Sediment Benchmark	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
EWSED01	0.018 J	< 0.0006	0.024	0.015	0.015	0.148
EWSED02	< 0.005	0.0007	0.03	0.029	0.03	0.259
EWSED02DUP	--	--	--	--	--	--
EWSED03	< 0.004	0.0011	0.057	0.038	0.012	1.55
EWSED04	0.05	0.0012	0.16	0.088	0.016	1.02
EWSED05	< 0.004	< 0.0005	0.082	0.055	0.011	1.74
EWSED06	0.33	0.0019	0.092	0.04	0.019	3.79
EWSED07	--	--	--	--	--	--
EWSED08	2.04	< 0.0008	0.016	0.021	0.028	0.255
EWSED09	0.004	< 0.0005	0.011	0.009	0.005	0.039

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

DATA SUMMARY FOR NORTH AREA WETLAND SEDIMENTS
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	∑SEM, µmol/gsed	∑SEM/AVS	foc,goc/gsed	∑SEM-AVS, µmol/gsed	(∑SEM-AVS)/foc, µmol/goc
TCEQ Marine Sediment Benchmark	*NA*	*NA*	*NA*	*NA*	*NA*
EWSED01	0.2	11.3	0.0594	0.185	3.1
EWSED02	0.3	69.7	0.0273	0.344	12.6
EWSED02DUP	--	--	--	--	--
EWSED03	1.7	415	0.0182	1.654	90.9
EWSED04	1.3	25.7	0.0167	1.235	74
EWSED05	1.9	472	0.0181	1.885	104.1
EWSED06	3.9	11.9	0.0215	3.613	168
EWSED07	0.7	184	0.0239	0.731	30.6
EWSED08	0.3	0.157	0.0468	--	--
EWSED09	0.1	16.1	0.0112	0.061	5.4

Notes:
Values in mg/kg, dry weight
IW = Intercoastal Waterway
J = Estimated Concentration
L = Concentratin Biased Low
< indicates samples was below indicated detection limit.
mg/kg = milligrams per kilograms
AVS = Acid Volatile Sulfides
SEM = Simultaneously Extracted Metals
-- Not Analyzed

Values in **bold** exceed screening benchmark

TABLE 3

DATA SUMMARY TABLE FOR NORTH AREA WETLAND SEDIMENT PORE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID *TCEQ Marine Surface Water Benchmark*	**2-Methylnaphthalene** *0.03*	**4,4'-DDT** *0.000001*	**Acenaphthene** *0.0404*	**Acenaphthylene** *NA*
EWSED01	0.000018 U	< 0.000012 J	<0.0000052	0.000024
EWSED02	0.000026 U	< 0.0000047 J	<0.0000044	<0.0000034
EWSED03	0.000022 U	< 0.000016 J	<0.0000047	<0.0000036
EWSED04	0.000046	--	<0.0000085 J	0.000014 J
EWSED04DUP	--	--	--	--
EWSED06	0.000019 U	< 0.00000058	0.0000091 J	<0.0000035
EWSED07	0.000013 U	--	<0.000012	0.000032 J
EWSED08	0.0000083 U	**0.000003 J**	<0.000005	<0.0000039
EWSED09	0.000018 U	< 0.0000014 J	<0.0000044	<0.0000034

Notes:
Values in mg/L
mg/L = milligrams/liter
< or U indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

DATA SUMMARY TABLE FOR NORTH AREA WETLAND SEDIMENT PORE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID *TCEQ Marine Surface Water Benchmark*	**Anthracene** *0.00018*	**Arsenic** *0.078*	**Benzo(a)anthracene** *NA*	**Benzo(a)pyrene** *NA*	**Benzo(g,h,i)perylene** *NA*
EWSED01	0.000067	0.0037 J	<0.0000031	<0.0000051	0.000012 J
EWSED02	<0.0000036	0.0041 J	<0.0000026	<0.0000043	0.000012 J
EWSED03	0.000013 J	0.0019 J	<0.0000028	<0.0000046	<0.0000031
EWSED04	0.000047	0.00072 J	<0.0000026	<0.0000043	<0.0000029
EWSED04DUP	--	0.00325	--	--	--
EWSED06	<0.0000037	0.00177 J	0.0000095 U	0.0000097 U	0.000023 U
EWSED07	0.000066	0.00063 J	<0.0000067	<0.000012	<0.0000075
EWSED08	<0.0000041	0.00576 J	<0.000003	<0.0000049	<0.0000033
EWSED09	<0.0000036	0.00171 J	<0.0000026	<0.0000043	<0.0000029

Notes:
Values in mg/L
mg/L = milligrams/liter
< or U indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 3

DATA SUMMARY TABLE FOR NORTH AREA WETLAND SEDIMENT PORE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	**Chrysene**	**Copper**	**Dibenz(a,h)anthracene**	**Endrin Aldehyde**
TCEQ Marine Surface Water Benchmark	*NA*	*0.0036*	*NA*	*0.000002*
EWSED01	<0.000004	0.000922	<0.000003	**0.000013**
EWSED02	0.000049	0.000342 U	0.0000034 J	**0.0000067** J
EWSED03	<0.0000036	**0.00456**	<0.0000027	**0.000015** J
EWSED04	<0.0000034	**0.00426**	<0.0000025	--
EWSED04DUP	--	**0.00531** U	--	--
EWSED06	0.0000096 U	**0.00702**	0.000015 U	<0.00000046
EWSED07	<0.0000088	0.00303	<0.0000065	--
EWSED08	<0.0000039	0.00137	<0.0000029	**0.0000026** J
EWSED09	<0.0000034	0.000761 U	<0.0000025	<0.0000033 J

Notes:
Values in mg/L
mg/L = milligrams/liter
< or U indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 3

DATA SUMMARY TABLE FOR NORTH AREA WETLAND SEDIMENT PORE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID *TCEQ Marine Surface Water Benchmark*	Endrin ketone *0.000002*	Fluorene *0.05*	Fluoranthene *0.00298*	gamma-Chlordane *0.000004*
EWSED01	<0.00000078	0.000013 J	<0.0000052	<0.00000038
EWSED02	<0.0000013 J	<0.0000038	<0.0000044	<0.0000013 J
EWSED03	**0.000007** J	<0.000004	<0.0000047	<0.000016 J
EWSED04	--	0.0000047 J	<0.0000044	--
EWSED04DUP	--	--	--	--
EWSED06	<0.00000066	0.0000091 J	<0.0000045	<0.00000032
EWSED07	--	<0.0000098	<0.000012	--
EWSED08	<0.0000007	<0.0000044	<0.000005	0.0000033 J
EWSED09	<0.0000011	<0.0000038	<0.0000044	<0.000016 J

Notes:
Values in mg/L
mg/L = milligrams/liter
< or U indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 3

DATA SUMMARY TABLE FOR NORTH AREA WETLAND SEDIMENT PORE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	**Indeno(1,2,3-cd)pyrene**	**Lead**	**Nickel**	**Phenanthrene**	**Pyrene**	**Zinc**
TCEQ Marine Surface Water Benchmark	*NA*	*0.0053*	*0.0131*	*0.0046*	*0.00024*	*0.0842*
EWSED01	0.0000051 J	0.000115 U	0.00944	0.000012 J	<0.0000042	0.0101
EWSED02	0.0000062 J	0.000113 U	0.00486	<0.000005	<0.0000035	0.00135 U
EWSED03	<0.0000028	0.000425 U	0.00749 U	0.0000053 U	<0.0000037	0.0413
EWSED04	<0.0000026	0.00015 U	0.0114	<0.000005	<0.0000035	**0.101**
EWSED04DUP	--	0.000239 U	--	--	--	0.083
EWSED06	0.000014 U	0.000443 U	0.00915	0.0000068 J	<0.0000036	**0.626**
EWSED07	<0.0000067	0.000184	0.00917	<0.000013	<0.000009	0.0599
EWSED08	<0.000003	0.00128 U	**0.0142**	<0.0000057	<0.000004	0.039
EWSED09	<0.0000026	0.000236 U	0.00669	<0.000005	<0.0000035	0.00124 U

Notes:
Values in mg/L
mg/L = milligrams/liter
< or U indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 4

DATA SUMMARY FOR NORTH AREA WETLAND SURFACE WATER
GULFCO MARINE MAINTENANCE SUPERFUND SITE

Sample ID	**Acrolein**	**Copper**	**Nickel**	**Silver**	**Zinc**
TCEQ Marine Surface Water Benchmark	*0.005*	*0.0036*	*0.0131*	*0.00019*	*0.0842*
EWSW01	<0.00096	0.00338 J	0.00616	0.000020 J	0.029
EWSW01DUP	<0.00096	0.00331	0.00601	0.000021 J	0.0279
EWSW03	--	**0.00854**	0.00474	0.000049	0.0242
EWSW04	--	0.00154	0.00396	0.000011 J	**0.122**

Notes:
Values in mg/L
mg/L = milligrams/liter
< indicates samples was below indicated detection limit.
J = Estimated Concentration
-- Not Analyzed
Values in **bold** exceed screening benchmark

TABLE 5
Page 1 of 1
SUMMARY OF TOXICITY TESTING FOR NORTH AREA SOIL AND SEDIMENT
GULFCO MARINE MAINTENANCE SUPERFUND SITE

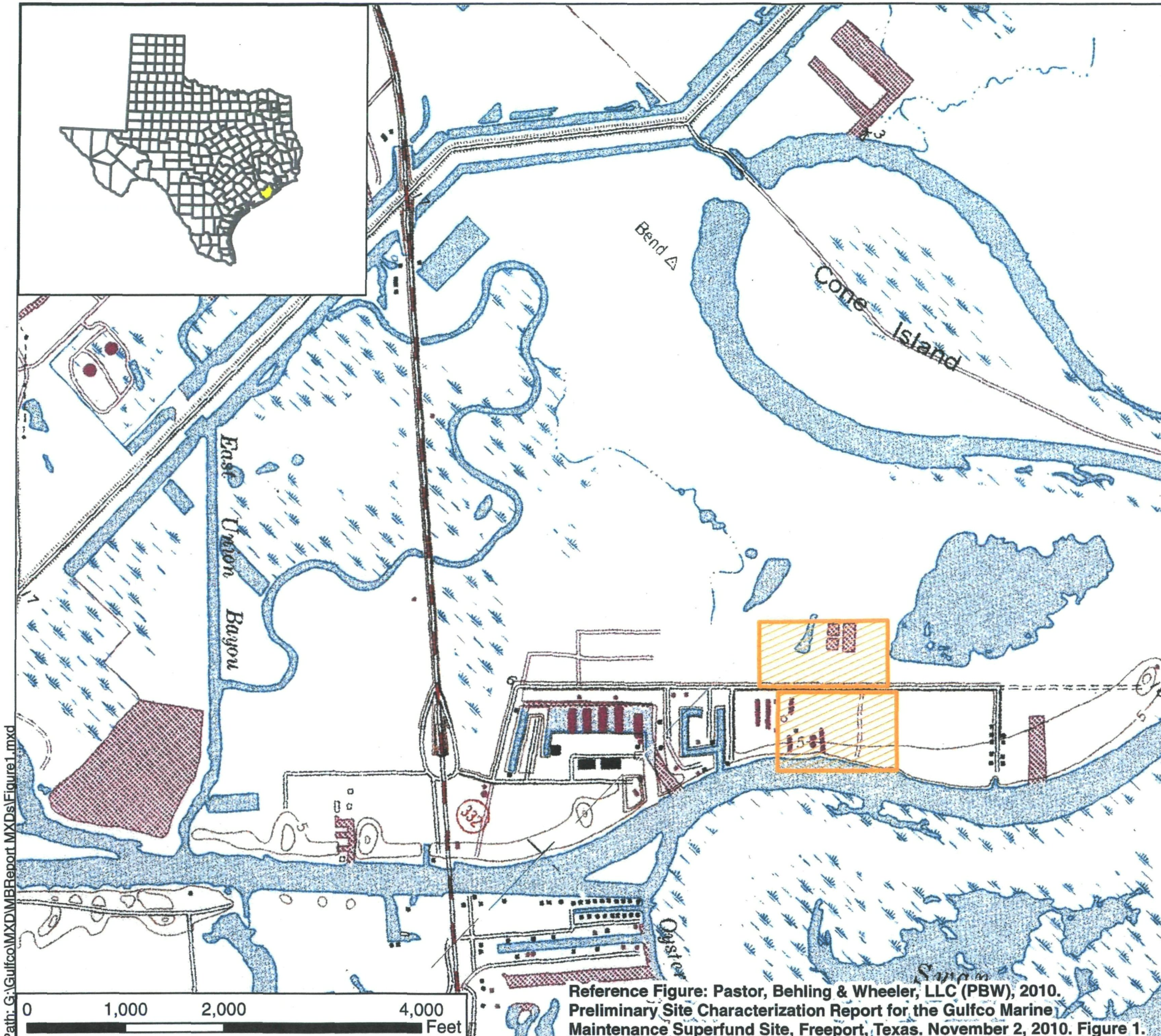
North Area Soils	*21-day Neanthes arenaceodentata:* Survival and Growth		
Sample ID	**Survival (%)**	**Growth - Biomass (mg)**	**Growth - Dry Wt. (mg)****
Lab Control for North Area Soils	100	2.058	2.058
Site Locations:			
BERA SAmple ID: NAS01	76	0.6648	0.9817
BERA Sample ID: NAS02	88	2.123	2.407
BERA Sample ID: NAS03	96	2.603	2.704
BERA Sample ID: NAS04	84	4.52	5.423
BERA Sample ID: NAS05	76	1.998	2.695
BERA Sample ID: NAS06	88	1.648	1.894
North Area Reference Locations:			
BERA Sample ID: NAS07	92	1.533	1.679
BERA Sample ID: NAS08	64	0.688	1.008
BERA Sample ID: NAS09	60	0.5512	0.9815

Wetlands Sediments	*28-day Neanthes arenaceodentata:* Mean Survival and Growth			*28-day Leptocheirus plumulosus:* Mean Survival, Growth and Reproduction			
Sample ID	**Survival (%)**	**Growth - Biomass (mg)**	**Growth - Dry Wt. (mg)****	**Survival (%)**	**Offspring (Mean)**	**Growth - Biomass (mg)**	**Growth - Dry Wt. (mg)****
Lab Control *	96	4.073	4.28	81.5	5.3	0.6773	0.8304
Site Locations:							
BERA Sample ID: EWSED01	96	3.073	3.234	35	0	0.2607	0.6566
BERA Sample ID: EWSED02	76	2.285	3.334	58	0.2	0.2313	0.4916
BERA Sample ID: EWSED03	84	2.004	2.421	20	0	0.2015	0.4202
BERA Sample ID: EWSED04	84	2.53	2.988	23.75	0	0.1518	0.529
BERA Sample ID: EWSED05	72	2.248	3.285	38	0	0.1614	0.4109
BERA Sample ID: EWSED06	80	1.78	2.36	13	0	0.05525	0.3764
BERA Sample ID: EWSED07	72	2.451	3.371	30	0.8	0.124	0.3924
Wetland Sediment Reference Locations:							
BERA Sample ID: EWSED08	66	1.586	2.741	33	0.6	0.2238	0.5988
BERA Sample ID: EWSED09	76	2.15	2.95	19	1.8	0.1162	0.5035

* Average of Lab Control 1 and 2

* * The primary growth endpoint Dry Wt is the dry weight of surviving organisms divided by the number of surviving organisms. Biomass (the dry weight of surviving organisms divided by initial number of organisms) is not routinely applied to sediment testing (EPA, 2000)

FIGURES

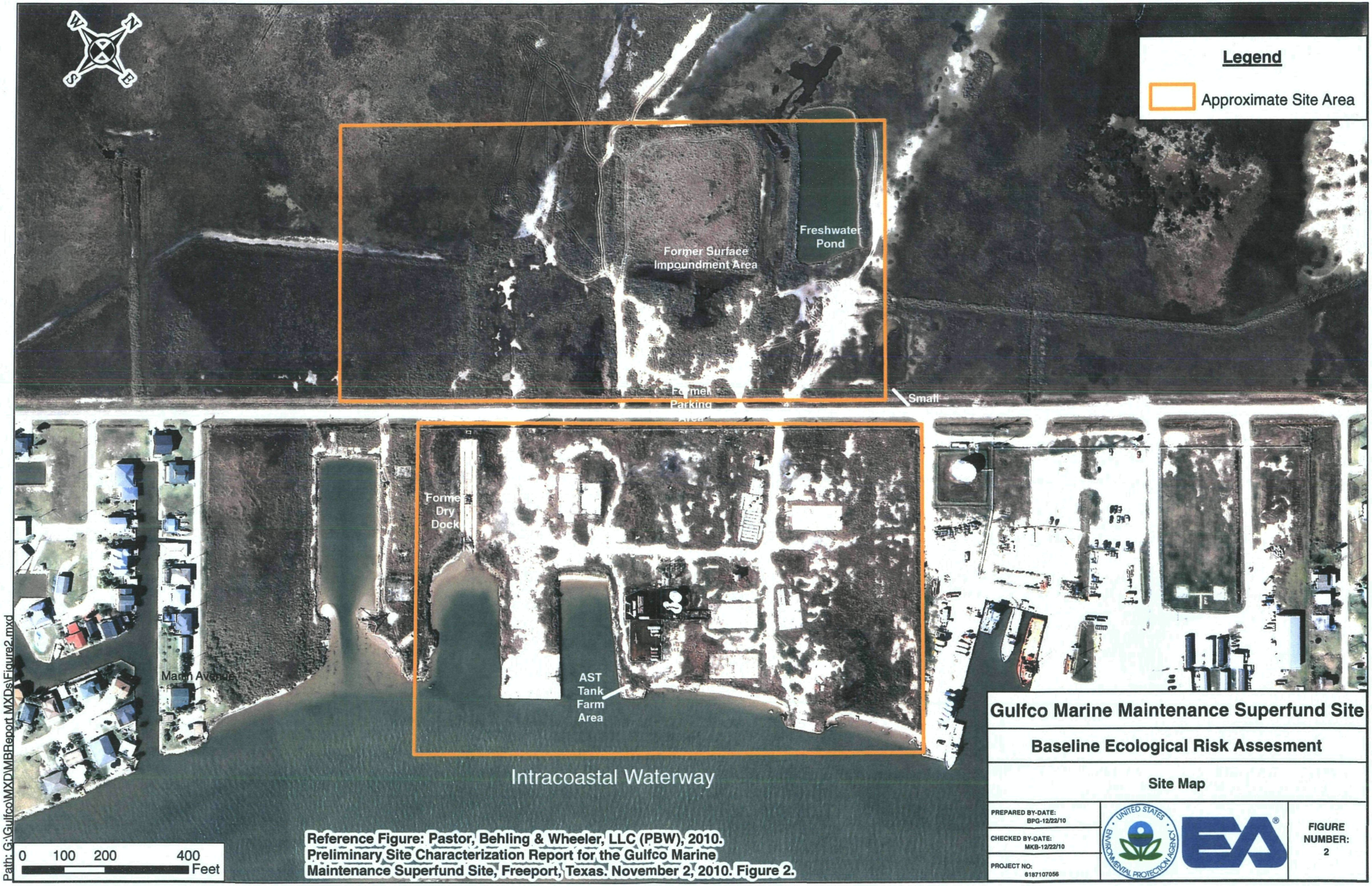


Gulfco Marine Maintenance Superfund Site

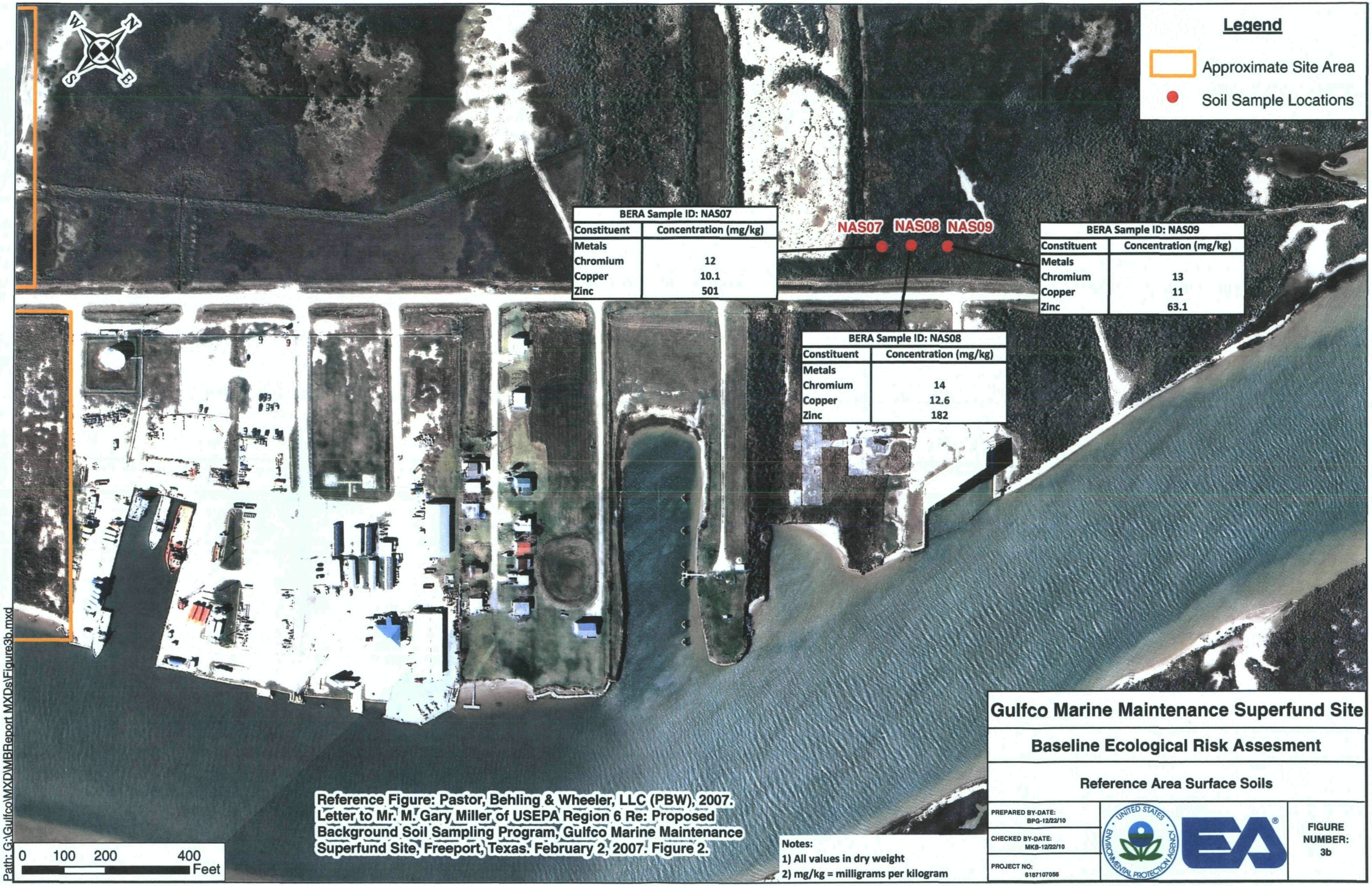
Baseline Ecological Risk Assesment

Site Location Map

PREPARED BY-DATE: BPG-12/22/10	FIGURE NUMBER: 1
CHECKED BY-DATE: MKB-12/22/10	
PROJECT NO: 6187107056	


W
N
S
E
Legend
Approximate Site Area
Freshwater Pond
Former Surface Impoundment Area
Parking
Small
Forme Dry Dock
AST Tank Farm Area
Marin Avenue
Intracoastal Waterway
0 100 200 400 Feet
Path: G:\Gulfco\MXD\MBReport MXDs\Figure2.mxd
Reference Figure: Pastor, Behling & Wheeler, LLC (PBW), 2010. Preliminary Site Characterization Report for the Gulfco Marine Maintenance Superfund Site, Freeport, Texas. November 2, 2010. Figure 2.
Gulfco Marine Maintenance Superfund Site
Baseline Ecological Risk Assesment
Site Map
PREPARED BY-DATE: BPG-12/22/10
CHECKED BY-DATE: MKB-12/22/10
PROJECT NO: 6187107056
FIGURE NUMBER: 2


W
N
S
E
Legend
Approximate Site Area
Soil Sample Locations
Notes:
1) All values in dry weight
2) mg/kg = milligrams per kilogram
NAS06
Former Surface Impoundment Area
BERA Sample ID: NAS01
Constituent | Concentration (mg/kg)
Metals
Chromium 97
Copper 221
Zinc 5770
NAS01
NAS02
NAS03
NAS05
NAS04
Marlin Avenue
Path: G:\Gulfco\MXD\MBReport MXDs\Figure3a.mxd
0 100 200 400
Feet
Reference Figure: Reference Figure: Pastor, Behling & Wheeler, LLC (PBW), 2010. Preliminary Site Characterization Report for the Gulfco Marine Maintenance Superfund Site, Freeport, Texas. November 2, 2010. Figure 2.
Gulfco Marine Maintenance Superfund Site
Baseline Ecological Risk Assesment
Sample Locations and Potential Stressors in North Area Soils
PREPARED BY-DATE: BPG-12/22/10
CHECKED BY-DATE: MKB-12/22/10
PROJECT NO: 6187107056
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
EA
FIGURE NUMBER: 3a



BERA Sample ID: NAS07	
Constituent	Concentration (mg/kg)
Metals	
Chromium	12
Copper	10.1
Zinc	501

BERA Sample ID: NAS08	
Constituent	Concentration (mg/kg)
Metals	
Chromium	14
Copper	12.6
Zinc	182

BERA Sample ID: NAS09	
Constituent	Concentration (mg/kg)
Metals	
Chromium	13
Copper	11
Zinc	63.1

Reference Figure: Pastor, Behling & Wheeler, LLC (PBW), 2007. Letter to Mr. M. Gary Miller of USEPA Region 6 Re: Proposed Background Soil Sampling Program, Gulfco Marine Maintenance Superfund Site, Freeport, Texas. February 2, 2007. Figure 2.

Notes:
1) All values in dry weight
2) mg/kg = milligrams per kilogram

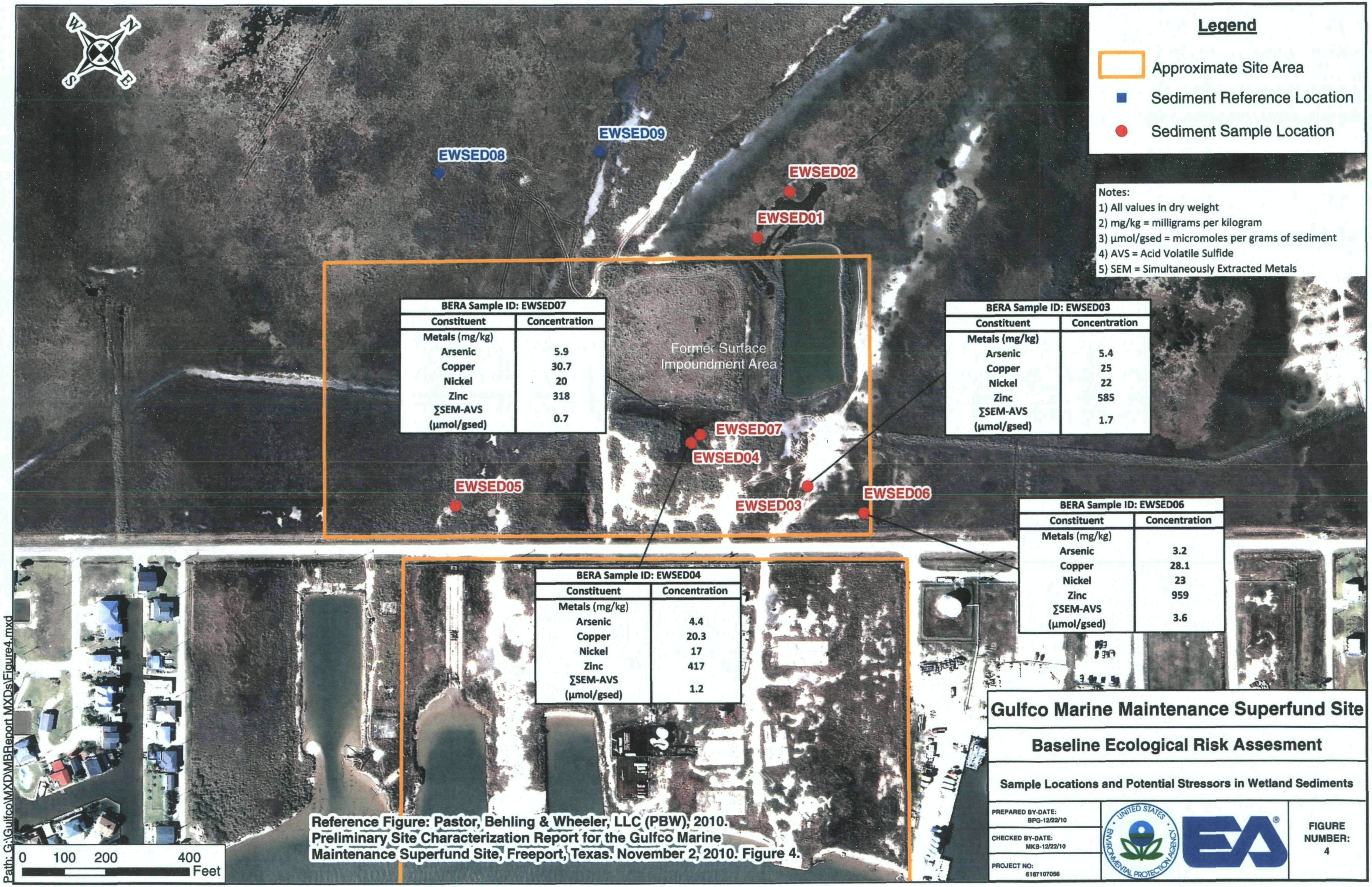
Gulfco Marine Maintenance Superfund Site

Baseline Ecological Risk Assesment

Reference Area Surface Soils

PREPARED BY-DATE: BPG-12/22/10
CHECKED BY-DATE: MKB-12/22/10
PROJECT NO: 6187107056

FIGURE NUMBER: 3b

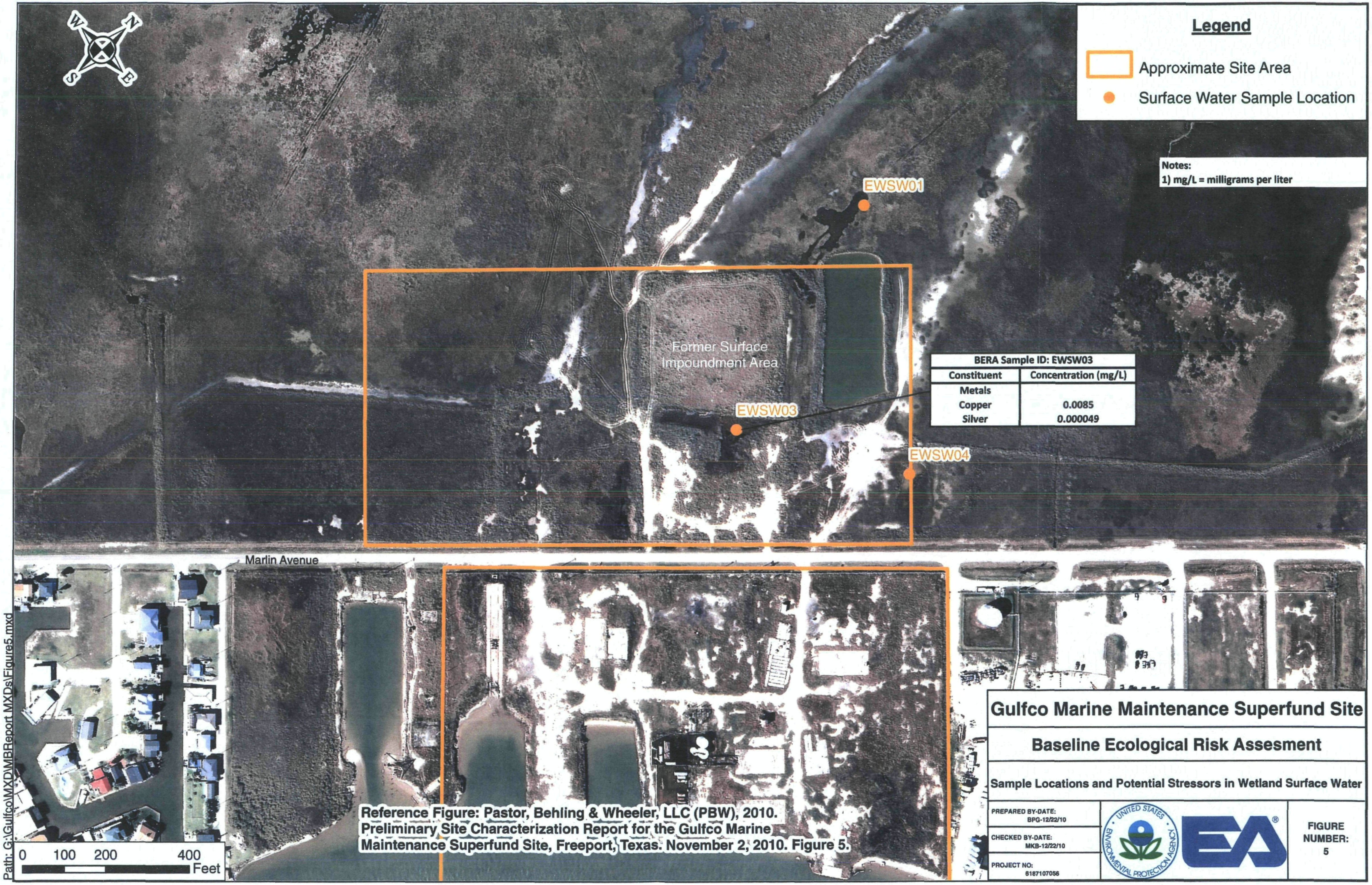


BERA Sample ID: EWSED07	
Constituent	Concentration
Metals (mg/kg)	
Arsenic	5.9
Copper	30.7
Nickel	20
Zinc	318
∑SEM-AVS (µmol/gsed)	0.7

BERA Sample ID: EWSED03	
Constituent	Concentration
Metals (mg/kg)	
Arsenic	5.4
Copper	25
Nickel	22
Zinc	585
∑SEM-AVS (µmol/gsed)	1.7

BERA Sample ID: EWSED06	
Constituent	Concentration
Metals (mg/kg)	
Arsenic	3.2
Copper	28.1
Nickel	23
Zinc	959
∑SEM-AVS (µmol/gsed)	3.6

BERA Sample ID: EWSED04	
Constituent	Concentration
Metals (mg/kg)	
Arsenic	4.4
Copper	20.3
Nickel	17
Zinc	417
∑SEM-AVS (µmol/gsed)	1.2



BERA Sample ID: EWSW03	
Constituent	Concentration (mg/L)
Metals	
Copper	0.0085
Silver	0.000049

Reference Figure: Pastor, Behling & Wheeler, LLC (PBW), 2010. Preliminary Site Characterization Report for the Gulfco Marine Maintenance Superfund Site, Freeport, Texas. November 2, 2010. Figure 5.

Gulfco Marine Maintenance Superfund Site

Baseline Ecological Risk Assesment

Sample Locations and Potential Stressors in Wetland Surface Water

PREPARED BY-DATE: BPG-12/22/10	FIGURE NUMBER: 5
CHECKED BY-DATE: MKB-12/22/10	
PROJECT NO: 6187107056	